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FRIDAY, NOVEMBER 8, 1901.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SUPPLEMENTARY REPORT ON NON-EUCLIDEAN GEOMETRY.

WHEN at the Columbus meeting of the American Association I had the honor of making a 'Report on Non-Euclidean Geometry,' it was mentioned that my own 'Bibliography of Hyper-space and Non-Euclidean Geometry,' in the *American Journal of Mathematics* (1878), giving 81 authors and 174 titles, when reprinted in the collected works of Lobachevski (Kazan, 1886) gives 124 authors and 272 titles; while Roberto Bonola had just given (1899) a 'Bibliography of the Foundations of Geometry in Relation to Non Euclidean Geometry,' containing over 350 titles with some repetitions.

Bonola in 1900 finished a second part of this bibliography, in which the single section headed 'Historical, Critical and Philosophical Writings' gives 96 authors and 150 titles. It thus becomes very evident that a most important function of your reporter is the selection of what writings to bring forward for especial mention as of paramount importance and typical of the main stream of advance.

In the Columbus report I particularly stressed the work of two authors whom I brought forward together and to whom I devoted about a quarter of that report.

The report first appeared in *SCIENCE* for October 20, 1899, and you may imagine

that it was reassuring when on October 22 (old style), 1900, the Commission of the Physico-Mathematical Society of Kazan found the scientific merits of the works of these authors, A. N. Whitehead and Wm. Killing equal for the great Lobachevski prize and had to decide between them by the drawing of lots.

In his report on the work of Whitehead, Sir Robert Ball says of the 'Universal Algebra':

"Several other writers, to whom of course Mr. Whitehead makes due acknowledgment, have approached the study of non-Euclidean geometry by the aid of Grassmann's methods, but the systematic and most instructive development of the subject in book VI. is, I believe, new, as are also many of the results obtained.

"The superiority of Whitehead's methods appears to lie in the two following features:

"1°. That he can treat n dimensions by practically the same formulæ as those used for two or three dimensions.

"In this I think he has made a considerable advance upon the methods, ingenious and beautiful as some of them no doubt are, which have been used by previous investigators.

"2°. The various kinds of space, parabolic, hyperbolic and elliptic (of two kinds), present themselves in Whitehead's methods quite naturally in the course of the work, where they appear as the only alternatives when certain assumptions have been made.

"Moreover the results have been obtained in such a way that it is easy for the reader to develop for one of the other spaces properties treated out in full for one space only.

"The book deserves in the highest degree the attention of the student of modern mathematical methods, and it marks so great an advance that it is, in my judgment, well worthy of the important prize in view of which this report is prepared.

"Mr. Whitehead's memoir on geodesics in elliptic space appears to me to indicate great power in dealing with a very difficult problem. I believe it to be of much importance, as the geodesics in the generalized space conceptions had been but little studied."

In the corresponding report on the work of Killing, Professor Engel, of Leipsic, says of the 'Grundlagen der Geometrie':

"This work is, from the first to the last page, a justification and detailed development of the circle of ideas which we are accustomed to understand under the expression 'non-Euclidean geometry.'"

"Already so many preliminary questions have been settled," said Killing in the preface to his first volume, "that the final solution can be hoped for at a not too distant time."

"These words written in 1893," says Engel, "have meanwhile most recently (1899) found a highly striking confirmation in many directions through Hilbert's investigations.

"The geometries possible with the Euclidean, namely the Lobachevski-Bolyaïan, the Riemannian and the elliptic, Killing develops, each for itself, in Euclidean way up to a certain grade.

"Also it should not be forgotten that Killing was the first, who (1879, *Crelles Journal*, Bd. 83) made clear the difference between the Riemannian and the elliptic space (or as he calls it, the Polar form of the Riemannian).

"The fourth section treats the Clifford-Klein space-forms, in whose investigation Killing himself has taken a conspicuous part (by a work in Bd. 39 of the *Mathematische Annalen*, 1891). The great importance of these space-forms rests upon this, that they show with especial clearness, what a mighty difference it makes whether we, from the beginning, assume the geometric axioms as valid for space as a whole

or merely for an every way bounded piece of space. In the first case we obtain, besides the Euclidean, only the three previously mentioned non-Euclidean space-forms.

"In the second case appears also a manifoldness, at present not yet dominated, of different space forms.

"The treatment of continuity and the ratio-idea in Euclid gives occasion for a nearer investigation of the so-called Archimedes' Axiom.

"Finally, as the first attempt to illuminate in conjunction all the different questions which have grouped themselves about the problem mentioned, and to collect all the means, which numerous mathematicians, and not least the author himself, have made for solving the problem, this work will for long retain its value.

"That precisely the founding of geometry since the appearance of this book has been advanced in a wholly unexpected way by Hilbert, cannot lessen Killing's merit. His work remains still by far the best means for mastering the researches which have appeared in this realm up to 1898." These interesting extracts I take from the Russian pamphlet just issued at Kazan and furnished me by my friend Professor Vasiliev.

In his paper 'Ueber Nicht-Euklidische und Linien-Geometrie' (Greifswald, 1900), Professor E. Study voices a profound truth when he says: "The conception of geometry as an experimental science is only one among many possible, and the standpoint of the empiric is as regards geometry by no means the richest in outlook. For he will not, in his one-sidedness, justly appreciate the fact that in manifold and often surprising ways the mathematical sciences are intertwined with one another, that in truth they form an indivisible whole.

"Although it is possible and indeed highly desirable, that each separate part or theory be developed independently from the others and with the instrumentalities

peculiar to it, yet whoever should disregard the manifold interdependence of the different parts, would deprive himself of one of the most powerful instruments of research.

"This truth, really self-evident yet often not taken to heart, applied to Euclidean and non-Euclidean geometry, leads to the somewhat paradoxical result that, among conditions to a more profound understanding of even very elementary parts of the Euclidean geometry, the knowledge of the non-Euclidean geometry cannot be dispensed with."

That the world has caught one deduction from this deep idea, is shown by the fact of the almost simultaneous appearance of two text-books, manuals for class use, to make universally attainable this necessary condition for any thorough understanding of any geometry, even the most elementary; two intended, available popular treatises on this ever more essential non-Euclidean geometry.

One of these, just being issued by G. Carré et C. Naud, 3 rue Racine, Paris, is 'La géométrie non Euclidienne,' by P. Barbarin, professor at Bordeaux, a place made sacred for non-Euclideans by the memory of Hoüel. How great and practical is the interest of this book can be gathered from the headings of its chapters.

I. 'General and historical considerations.' How the non-Euclidean doctrine was born and gradually developed.

II. 'Euclid's definitions and postulates.' Study of the rôle that they play in the principles of geometry.

Simple and elementary exposé of the three geometries after the method of Saccheri.

III. 'Distance as fundamental notion.' The definitions of the straight and the plane according to Cauchy. The works of M. De Tilly.

IV. 'General geometry in the plane and in space.' Résumé of the principal general propositions.

V. 'Trigonometry.' Elementary demonstration, after Gérard and Mansion, of the formulas for triangles and quadrilaterals.

VI. 'Measurement of areas and volumes.'

VII. 'The contradictors of the non-Euclidean geometry.' The principal objections made against the non-Euclidean geometry. Answers to be made thereto.

VIII. 'Physical geometry.' How we might attempt to find out if the physical world is not Euclidean; how angles and distances could be measured with a much greater approximation, for example, angles with an error much less than $\frac{1}{100}$ of a second.

A brief article by Professor Barbarin, 'On the utility of studying non-Euclidean geometry,' which appears in the May (1901) number of Professor Cristoforo Alasia's new Italian journal *Le Matematiche*, shows that Hoüel had reached the weighty insight which we have quoted from Study, namely, that knowledge of non-Euclidean geometry is essential for any mastery of Euclidean geometry.

Says Barbarin:

"I. The question of the source of the theory of parallels has been one of the most interesting scientific preoccupations of the century; it has made to flow torrents of books, and given theme to remarkable works. Thanks to the theorems of Legendre, to the discoveries of the two Bolyai, of Lobachevski and of Riemann; thanks to the original researches of Beltrami and of Sophus Lie, of Poincaré, Flye Ste. Marie, Klein, De Tilly, etc., we cannot any more be mistaken as to the true scope of the celebrated proposition which bears the name of Postulate of Euclid.

"1°. This is not in any way contained in the classic definitions of the straight and the plane.

"2°. This is, among three hypotheses equally admissible, and which cannot all be rejected, only the most simple.

"Is it perhaps chance alone which gave to the great Greek geometer the choice of his system of geometry? or did he perceive, at least in part, the difficulties and the greater theoretic complication of the other two? We shall never know with certainty.

"But in the presence of his work, so perfect and so rigorous, one thing, however, appears not to be doubtful: the place which he assigned to his proposition, the enunciation which he gave of it, attest that this proposition had to his eyes only the value of an hypothesis; otherwise he would have formulated it in other terms and would have attempted to demonstrate it.

"The ideas of Lobachevski and of Riemann were diffused only very slowly. They were so, above all, thanks to the translations of Hoüel.

"This scientist, whose activity and power of work were prodigious, could not resist the desire to master all the European languages, with the aim of being able to read in their original text, and then make known to his contemporaries the most celebrated mathematical works.

"He admired Lobachevski, whom he sur-named the *modern Euclid*, and in his course professed at the scientific faculty of Bordeaux, he did not let pass any occasion to put him in evidence.

"II. Hoüel was persuaded that the knowledge of the non-Euclidean geometry is indispensable for thoroughly mastering the mechanism of the Euclidean geometry.

"Despite its paradoxical form, this idea is most just.

"General geometry or *metageometry* contains in fact a great number of propositions common to all the systems, and which ought to be enunciated in the same terms in each

of these. If the general proposition can be demonstrated in terms general for these, such should be preferred, even if, to attain this, it be necessary to subject the ordinary form to some modification. To cite only one example, we take the convex quadrilateral inscribed in a circle.

"In Euclidean geometry, the sum of two opposite angles is constant and equal to two right angles; in non-Euclidean geometry this sum is variable. Notwithstanding this, the two forms may be reconciled, since in both cases the sum of two opposite angles equals that of the other two, and this is sufficient for a convex quadrilateral to be inscriptible.

"Confronting the proposition with that which concerns the circumscribed quadrilateral, we put in full light a correlation which, *à priori*, ought evidently to exist.

"This correlation, which is the very heart of general geometry, and which does not always appear in the ordinary geometry with the same clearness, can be utilized for finding new properties of the figures.

"Example: Every conic is the locus of the points such that the sum of the tangents from these drawn to two circles is constant; every conic then will also be the curve envelope of the straights which cut two given circles under angles of which the sum is constant. (Excellent problem for investigating directly.)

"III. Is it expedient to associate the non-Euclidean geometry with instruction, and in what measure?

"If we treat of higher instruction, with ardor we respond affirmatively.

"In the courses of higher geometry of the universities the names of Bolyai, Lobachevski, Riemann have their assigned place, and there are still divers unexplored domains on the road which these scientists have opened.

"In so far as it refers to secondary instruction, the question is more delicate. The programs of preparatory courses at the high schools contain all, or almost all,

special mathematics and spherical geometry.

"It would not be then a great inconvenience to there make opportunely a discrete allusion to general geometry: on the contrary, the attention of the students and their critical spirit would be held awake by the necessity of investigating if such proposition which is expounded to them is of order particular or general.

"At least two indispensable conditions should be satisfied; it is requisite:

"1°. That in all the books put in the hands of the students, the hypothetical and wholly factitious character of the Euclidean postulate be put well into relief.

"In my classes I have recourse with success to the simple procedure which follows, and which I recommend. Take the straight AB and the two equal perpendiculars AB , BD : the angles ACD , BDC are equal, and may be right, acute or obtuse. But whichever be the one among these three hypotheses which we assume for this particular quadrilateral, we must conserve it for all the other like quadrilaterals. We choose the system of geometry in which these are right angles, and which corresponds to the Euclidean hypothesis.

"2°. That the invertibility of the postulate of Euclid be completely given up in all the demonstrations in which it can be done without and where nevertheless it is wrongly used.

"See, for example, the theorem on the face angles of a trihedral or polyhedral angle.

"We should recognize that great advances have been made in these latter years in the sense indicated.

"If the ideas of general geometry tend to become popularized, the honor of it is due above all to the periodicals which have given their hospitality, and in special manner to *Mathesis*, so ably edited by our excellent confrère, P. Mansion of Ghent.

"In the course of the last eight or ten years this journal has published numerous articles on Metageometry, written with as much competence as good sense. We counsel their perusal."

It will be seen from our quotation, that Professor Barbarin bases his exposition on the method of Saccheri as the simplest.

The same is true in the other new textbook, 'Manning's Non-Euclidean Geometry.' (Boston, Ginn & Co., 1901, 8vo, pp. v+95.)

Saccheri's first proposition is (*American Mathematical Monthly*, June, 1894, Vol. I., p. 188):

"If two equal straight lines, AC , BD , make with the straight AB angles equal toward the same parts: I say the angles at the join CD will be mutually equal."

On the next page is "Proposition II. The quadrilateral $ABCD$ remaining the same, the sides AB , CD are bisected in points M and H . I say the angles at the join MH will be on both sides right."

Professor Manning paraphrases these two together on page 5.

"If two equal lines in a plane are erected perpendicular to a given line, the line joining their extremities makes equal angles with them and is bisected at right angles by a third perpendicular erected midway between them."

Under the heading 'Definitions,' Saccheri says: "Since (from our first) the straight joining the extremities of equal perpendiculars standing upon the same straight (which we will call base), makes equal angles with these perpendiculars, three hypotheses are to be distinguished according to the species of these angles.

"And the first, indeed, I will call hypothesis of right angle; the second, however, and the third I will call hypothesis of obtuse angle, and hypothesis of acute angle." This Manning paraphrases as follows, under the heading 'The Three Hypotheses':

"The angles at the extremities of two equal perpendiculars are either right angles, acute angles, or obtuse angles, at least for restricted figures. We shall distinguish the three cases by speaking of them as the hypothesis of the right angle, the hypothesis of the acute angle, and the hypothesis of the obtuse angle respectively."

Saccheri's Proposition III. is: "If two equal straight lines, AC , BD , stand perpendicular to any straight line, AB : I say the join CD will be equal, or less, or greater than AB , according as the angles at CD are right, or obtuse, or acute."

This Manning paraphrases as follows: "The line joining the extremities of two equal perpendiculars is, at least for any restricted portion of the plane, equal to, greater than or less than the line joining their feet in the three hypotheses respectively."

In the same way is paraphrased Saccheri's Prop. IV., the converse of III.

Saccheri's corollary about quadrilaterals with three right angles is given by Manning on page 12.

Saccheri's Prop. V. is: "The hypothesis of right angle, if even in a single case it is true, always in every case it alone is true."

In giving this, Manning has: 'If the hypothesis of a right angle,' etc., evidently a slip for his usual *the* right angle. Of course the Latin original, of which I have, so far as I know, the only copy on this continent, has no article.

Prop. VI. and Prop. VII. are combined by Manning on p. 13.

Prop. IX. is reproduced on p. 14.

Prop. X. is given on p. 9.

In Prop. XI. Saccheri with the hypothesis of right angle demonstrates the celebrated Postulatum of Euclid, thus showing that his hypothesis of right angle is the ordinary Euclidean geometry.

Manning says, p. 27: "The three hypotheses give rise to three systems of geom-

etry, which are called the parabolic, the hyperbolic and the elliptic geometries. They are also called the Geometries of Euclid, of Lobachevski, and of Riemann." Now Saccheri in his demonstration of Prop. XI. makes, almost in the words of Archimedes, an assumption, introduced by the words 'it is manifest,' which we now call, for convenience, Archimedes' Axiom. In his futile attempts at demonstrating the parallel-postulate, Legendre set forth two theorems, called Legendre's theorems on the angle-sum in a triangle. They are:

1. In a triangle the sum of the three angles can never be greater than two right angles.
2. If in any triangle the sum of the three angles is equal to two right angles, so is it in every triangle.

In addition to assuming the infinity or two-sidedness of the straight, in his proofs of these theorems Legendre uses essentially the Archimedes Axiom. Thence he gets that the angle-sum in a triangle equaling two right angles is equivalent to the parallel-postulate, all of which is really what Saccheri gave a century before him, now just reproduced by Barbarin and Manning, as before by De Tilly. Even Hilbert in his 'Vorlesung ueber Euklidische Geometrie' (winter semester, 1898-99), for a chance to see Dr. von Schafer's Authographie of which I am deeply grateful to Professor Bosworth, gives the following five theorems and then says: "Finally we remark, that it seems as if each of these five theorems could serve precisely as *equivalent of the Parallel Axiom*." They are

1. The sum of the angles of a triangle is always equal to two right angles.
2. If two parallels are cut by a third straight, then the opposite (corresponding) angles are equal.
3. Two straights, which are parallel to a third, are parallel to one another.
4. Through every point within an angle less than a straight angle, I can always

draw straights which cut both sides [not perhaps their prolongations].

5. All points of a straight have from a parallel the same distance.

But since then a wonderful discovery has been made by M. Dehn.

It was known that Euclid's geometry could be built up without the Archimedes axiom. So arises the weighty question: *In such a geometry do the Legendre theorems necessarily hold good?*

In other words: Can we prove the Legendre theorems without making use of the Archimedes axiom?

This is the question which, at the instigation of Hilbert, was taken up by Dehn.

His article was published July 10, 1900 (*Mathematische Annalen*, 53 Band, pp. 404-439).

Dehn was able to demonstrate Legendre's second theorem without using any postulate of continuity, a remarkable advance over Saccheri, Legendre, De Tilly.

But his second result is far more remarkable, namely, that Legendre's first theorem is indemonstrable without the Archimedes axiom.

To prove this startling position, Dehn constructs a new non-Euclidean geometry, which he calls a 'non-Legendrean' geometry, in which through every point an infinity of parallels to any straight can be drawn, yet in which nevertheless the angle sum in every triangle is greater than two right angles.

Thereby is the undemonstrability of the first Legendre theorem without the help of the Archimedes axiom proven.

Dehn then discusses the connection between the three different hypotheses relative to the sum of the angles [the three hypotheses of Saccheri, Barbarin, Manning] and the three different hypotheses relative to the number and existence of parallels.

He reaches the following remarkable propositions:

From the hypothesis that through a given point we can draw an infinity of parallels to a given straight it follows, if we exclude the Archimedes axiom, *not* that the sum of the angles of a triangle is less than two right angles, but on the contrary that this sum may be (*a*) greater than two right angles, (*b*) equal to two right angles.

The first case (*a*) is proven by the existence of the non-Legendrean geometry.

To demonstrate the second case (*b*), Dehn constructs a geometry wherein the parallel-axiom does not hold good, and wherein nevertheless are verified all the theorems of Euclidean geometry; the sum of the angles of a triangle is equal to two right angles, similar triangles exist, the extremities of equal perpendiculars to a straight are all situated on the same straight, etc.

As Dehn states this result: There are non-Archimedean geometries, in which the parallel-axiom is not valid and yet the angle-sum in every triangle is equal to two right angles.

Such a geometry he calls '*semi Euclidean*.'

Therefore, it follows that none of the theorems, the angle-sum in the triangle is two right angles, the equidistantial is a straight, etc., can be considered as equivalent to the parallel-postulate, and that Euclid in setting up the parallel-postulate hit just the right assumption.

This is a marvelous triumph for Euclid.

Finally Dehn arrives at this surprising theorem:

From the hypothesis that there are no parallels, it follows that the sum of the angles of a triangle is greater than two right angles.

Thus the two non-Euclidean hypotheses about parallels act in a manner absolutely different with regard to the Archimedes Axiom.

The different results obtained may now be tabulated thus:

The angle-sum in the triangle is:	Through a given point we can draw to a straight:		
	No parallel.	One parallel.	An infinity of parallels.
$> 2R$	Elliptic geometry	(Impossible)	Non-Legendrean geometry
$= 2R$	(Impossible)	Euclidean geometry	Semi-Euclidean geometry
$< 2R$	(Impossible)	(Impossible)	Hyperbolic geometry

Riemann, Helmholtz and Sophus Lie founded geometry on an analytical basis in contradistinction to Euclid's pure synthetic method.

They elected to conceive of space as a manifold of numbers. In the Columbus report is an account of the Helmholtz-Lie investigation of the essential characteristics of space by a consideration of the movements possible therein.

This is notably simplified if we suppose given *à priori* the graphic concepts of straight and plane, and admit that movement transforms a straight or a plane into a straight or respectively a plane. Killing determines analytically the three types of projective groups, but the same results are reached in a way geometric and purely elementary by Roberto Bonola in a beautiful little article entitled, '*Determinazione, per via geometrica, dei tre tipi di spazio: Iperbolico, Ellittico, Parabolico* (*Rendiconti del Circolo Matematico di Palermo*, Tomo XV., pp. 56-65, April, 1901).

In 1833 was published in London the fourth edition of an extraordinary book (3d Ed., 1830) by T. Perronet Thompson of Queen's College, Cambridge, with the following title:

'Geometry without Axioms.'

"Being an attempt to get rid of Axioms and Postulates; and particularly to establish the theory of parallel lines without recourse to any principle not grounded on previous demonstration.

"To which is added an appendix containing notices of methods at different times proposed for getting over the difficulty in the 'Twelfth Axiom of Euclid.'" 8vo, pp. x + 148. This dissects most brilliantly twenty-one methods of getting rid of Euclid's postulate; so brilliantly that it deserves to be reprinted and could scarcely be improved upon. Then, nothing daunted by the failure of every one else of whom he has ever heard, the brave Thompson adds one of his own, which perhaps he also afterward impaled upon the point of his keen dissecting scalpel, for he lived long and prospered. In 1865 De Morgan, whose unknown letters to Sylvester I had the pleasure of publishing in the *Monist*, writes:

"With your note came an acknowledgment from General Perronet Thompson, B.A. of 1802, and Fellow of Queen's before he was an ensign. And he works at acoustics as hard as ever he did at the Corn Laws."

But even in 1833, had he but known it, the question of two thousand years, as to whether Euclid's Parallel-Axiom could be deduced, had been settled at last by the creation and indeed publication, by Bolyai, and also by Lobachevski, of a geometry in which it is flatly contradicted.

The newly created methods, which thus settled this old, old question, give entirely new views concerning the investigation of axioms in general; and this diamond mine has been masterfully preempted by Hilbert, of Göttingen. His wonderful 'Grundlagen der Geometrie' is ablaze with gems from this non-Euclidean mine.

After Bolyai and Lobachevski, Hilbert's closest forerunner is Friedrich Schur, of Karlsruhe. One of the most fundamental advances of this decade is the strict rigorous reduction of the comparison of areas to the comparison of sects.

This was first given on January 23, 1892, by Schur before the Dorpater Naturforscher-Gesellschaft.

The account printed in Russia in the society's *Proceedings*, a *Referat* given by Schur, is of course almost inaccessible, nor is this inaccessibility much lessened for us by the fact that it has been translated into Italian (*Per. di Mat.*, VIII., p. 153).

The essence of the matter is the proof that, a certain sect being taken as the measure of the area of a triangle, the sum of these sects is *the same* for any set of triangles into which a given polygon can be cut, and so gives a sect which may be taken as the measure of the area of the polygon. The *Referat* begins as follows:

"On the surface content of plane figures with straight boundaries, by Friedrich Schur.

"So simple a problem as the measuring of plane figures with straight boundaries as it seems from the literature to me accessible, has not yet been set forth with the rigor and purity of method herein possible.

"Not to mention the introduction of endless processes, still general magnitude-axioms are used unjustifiably, which are only then immediately clear when these magnitudes are straight sects, their comparison therefore capable of being made by superposition.

"Such a general magnitude-theorem, which is used in all text-books of elementary mathematics known to me in proving the theorem of the equal area of two parallelograms with common base and equal altitude, is, *e. g.*, this, that the subtraction of equal magnitudes from equal magnitudes gives again equal magnitudes.

"If the sides of the two parallelograms lying opposite the common base have a piece or at least a point in common, then the two parallelograms can at once be cut into parts such that each part of the one parallelogram corresponds to a part congruent to it of the other parallelogram.

"On the contrary, if those two sides have no point in common, then it has been be-

lieved that this method of proof for the equality of area, simple and standing upon a sharp definition, must be renounced, and it has been replaced, as is known, by this, that each of the two parallelograms is represented as the difference between the same trapez and one of two congruent triangles.

"But before the measurement of plane surfaces by sects has been attained, which just first becomes possible through the theorem to be proven, the application of the above magnitude-theorem is justified by nothing.

"We must therefore throw away this method of proof, and that so much the more, as in every case each of two parallelograms with common base and equal altitude in very simple way comprehensible to every scholar can be so cut into a number of parts that to each part of the one parallelogram corresponds a part congruent to it of the other.

"One may find that, *e. g.*, set forth in 'Stoltz's Vorlesungen' ueber allgemeine Arithmetik, I. Theil (Leipzig, 1885), S. 75 ff.

"We can still somewhat simplify this method, and lessen the number of parts. Draw, namely, through each of the two end-points next one another of the sides lying opposite the common base, parallels to the sides of the other parallelogram, and prolong these to the two outer of the sides not parallel to the base. The join of the two end-points so obtained is then parallel to the base, and cuts from the two parallelograms two new parallelograms which without anything further are divided into triangles every two congruent to one another.

"If then the sides opposite the common base of the remaining parallelograms again have no common point, then we proceed just so with them, and come thus, after a finite number of repetitions, to a pair of

parallelograms, to which the customary procedure can be applied.

"If the distance of those two neighboring end-points of the sides opposite the base is greater than the n fold of the base, on the other hand at the highest equal to the $(n+1)$ fold of the base, then is each parallelogram cut into a trapez (respectively triangle), three triangles and n parallelograms, and each of such parts of the one parallelogram corresponds to a part congruent to it of the other." Now it so happens that I myself had reached this method and published it seven years before Schur in my 'Elements of Geometry' (John Wiley & Sons, New York). It may be described more concisely as taking away pairs of congruent triangles each with base equal to the common base of the two parallelograms and sides respectively parallel to their other pairs of sides, until we have left two parallelograms to which the customary dissection into a triangle and trapezoid will apply, to finish with congruent parts.

But this demonstration, though the very simplest possible, yet postulates the Archimedes axiom, though neither I myself, in 1885, nor Schur, seven years later, in 1892, said a word about this assumption. However, before 1898 Schur became conscious that elementary geometry can be built up without the Archimedes axiom. He states this in the preface to his remarkable 'Lehrbuch der analytischen Geometrie' (Leipzig, Veit & Comp., 1898), referring to his article 'Ueber den Fundamentalsatz der projectiven Geometrie' *Math. Annalen*, Bd. 51), where he proves the theorems of Desargues and of Pascal without using either the parallel postulate or the axiom of Archimedes, proving that the ordinary sect-calculus can be built up independently of number-measure and the Archimedean postulate.

Professor Anne Bosworth, of Rhode

Island, has followed this up by actually constructing in her doctor's dissertation at Göttingen (1900), under Hilbert, a sect-calculus independent of the parallel-axiom.

This is a beautiful piece of non-Euclidean geometry, and is, so far as I know, the first feminine contribution to our fascinating subject.

In 1899 appeared Hilbert's 'Grundlagen der Geometrie,' in which the remarkable contributions of Schur are all retouched by a master hand.

In Schur's proof of the Pascal theorem the space axioms are used. Hilbert replaces them by the parallel-axiom, thus proving Pascal as a theorem of plane Euclidean geometry.

Schur makes a sect-calculus, and shows that the theory of proportion can be founded without the introduction of the difficult idea of the irrational number. He indicates that this could be done without the Archimedes axiom.

Hilbert actually does it.

Schur proves for the first time the fundamental theorem for a rigorous treatment of area.

Hilbert simplifies this proof, and proceeds to treat this whole subject without the Archimedes axiom, making here the new distinction between flächengleich and inhaltsgleich.

Two polygons are said to have *equal surface* when they can be resolved into a finite number of triangles congruent in pairs.

Two polygons are said to have *equal content* if it is possible to add to them polygons of equal surface, so that the two new compound polygons have equal surface.

Thus Euclid only tried to treat *equal content*, and Hilbert is here a return to the great Greek.

The intense interest in all these unexpected developments is voiced in a handsome volume: 'Questioni riguardanti la geometria elementare' (Bologna, 1900, 8vo,

pp. vii + 532), edited by Federigo Enriques, who has been chosen to contribute the part on the foundations of geometry to the great German Encyclopædia of the Mathematical Sciences, and who contributes the first article (28 pages) to this Italian work. It is entitled 'On the Scientific and Didactic Importance of the Questions which Relate to the Principles of Geometry.'

The whole book may be properly described as an outcome of the non-Euclidean geometry, but more specifically, the longest of the fourteen articles which make it up is by Bonola: 'On the Theory of Parallels and on the non-Euclidean Geometries' (80 pages, 26 figures).

The first fifty of his eighty pages are devoted to an historico-critical exposition; the last thirty to general theory, hyperbolic geometry, elliptic geometry. Though the article was published only last year, it is in certain respects antiquated. The proofs freely use the Archimedes postulate, without saying anything more about it than I did in 1885, that is, nothing at all. His § 7 is headed 'Postulates Equivalent to the Postulate of Euclid,' and gives those adopted by Proclus, Wallis, Bolyai Farkas, Carnot, Legendre, Laplace, Gauss. But now we know that all these men failed in attempting to rival the choice of Euclid. Their axioms are not the equivalent of his immortal postulate.

In this section the name Legendre is misspelled, and in § 5 Bonola says, "The attempts of Legendre for the demonstration of the Euclidean hypothesis, published in the various editions of the 'Elements' of Euclid, which appear under his name," etc.

Of course Legendre never published any edition of Euclid. It was on the contrary Legendre's geometry which cursed the subject with that definition, "A straight line is the shortest distance between two points,"

which still disgraces the beautifully illustrated book of Phillips and Fisher of Yale.

Again, in § 12 Bonola misquotes in a very important particular the title of the only thing Bolyai János ever published, his renowned appendix, in which title, instead of 'Johanne Bolyai de eadem,' Bonola has 'Johanne Bolyai de Bolya.' Again in § 8 Bonola is still expressing the hope that the examination of the unedited manuscripts of Gauss may show some ground for the pretence that Gauss had some part, however minute, in the creations of Bolyai, Lobachevski and Riemann. But these manuscripts have already been most sympathetically edited by Professor Paul Staeckel, their publication making a goodly quarto, in a review of which for *SCIENCE* under the heading 'Gauss and the non-Euclidean Geometry,' I find they only strengthen the already existing demonstration that neither of the creators of the non-Euclidean geometry owed even the minutest fraction of an idea or suggestion to Gauss.

This is reproven by the correspondence of Gauss and Bolyai Farkas, so sumptuously published in royal quarto by the Hungarian Academy of Science, edited by Staeckel and Franz Schmidt, chiefly valuable for its references to the immortal boy, Bolyai János, of whom unfortunately no portrait exists.

And now a word in conclusion.

Thinking is important for life. So much so that evolution in thinking has dominated all other evolution. In all thinking enters a creative element. There is not any pure receptivity. Nothing can be described except in terms of a precreated theory. The business of science is the making of these theories, and the continual remaking and bettering of these theories. The higher races of mankind, and chiefly the Greeks, created and elaborated a scheme for dominating what a popular terminology

calls the facts and laws presented by the spatial relations of things.

This scheme was only one of an indefinite number of possible schemes, but as coordinated and systematized by a great constructive genius, Euclid, the first professor of mathematics at the University of Alexandria, it proved so efficient, so effective for life, that all educated men accepted it as part of their common equipment.

Though it promises no heaven, though it threatens no hell, though it mentions no angels, no devils, yet Euclid's elements of geometry, simply as conveying a necessary instrument for the conduct of civilized life, has appeared in more than one thousand four hundred different editions [Professor Riccardi: *Saggio di una bibliografia Euclidea* (Bologna, 'Memorie' (5), I., 1890)].

Euclid gave to educated mankind a common language for description of the spatial, a common mental basis for thought about extension. Euclid's geometry is a certain theory for a specific natural science, a mental construction to explain, to master, to communicate or transmit, and to prophesy certain physical phenomena, the spatial or extensive phenomena. Therefore, the body of its doctrine is a system of theorems deduced in a logical way from certain unproven and in part absolutely and finally indemonstrable assumptions. Such a one is the world-renowned parallel-postulate, which is absolutely incapable of being proved in any way whatsoever, mental or physical, speculative or experimental, deductive or inductive. Therefore, to substitute for it a contradiction of it, in Euclid's scheme of fundamental assumptions, is to get with certainty another equally logical theory to do all that Euclid's geometry has ever done.

Of such systems each may throw light on the other, each may possess special advantages for particular applications.

But more than that: three such systems

used simultaneously may be able to accomplish what no one of them could do. This is beautifully illustrated in a theory communicated to me by F. W. Frankland, using a cosmic medium in which small regions of elliptic and hyperbolic space alternate, given a strain toward parabolic space which produces an elasticity or resilience simulating the properties with which physicists have endowed their hypothetical ether.

GEORGE BRUCE HALSTED.

UNIVERSITY OF TEXAS.

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE.

SECTION H, ANTHROPOLOGY.

THE effect of environment on the success of a meeting was well demonstrated at Denver. Local interest in the Section of Anthropology, fostered by the Colorado Cliff Dwellings' Association, had reached such a pitch even in advance of the opening session that the small room originally intended for the Section was abandoned for one with a seating capacity of 200. This large room was converted into a bazaar of rare aboriginal ceramics, Navajo blankets, basketry and pictures of Indian scenes by a committee from the Cliff Dwellings Association consisting of Mrs. J. D. Whitmore, Mrs. G. T. Sumner and Mrs. W. S. Peabody, all of Denver.

The meeting was memorable for sustained interest. The attendance was unprecedented, averaging at least 150 for the morning sessions; the afternoon audiences were also large.

Section H was organized on Monday morning, August 26, after the adjournment of the General Session, in accordance with the provisions of the constitution. The officers for the Denver meeting were as follows:

Vice-President, J. Walter Fewkes.

Secretary, George Grant MacCurdy.

Sectional Committee: A. W. Butler, vice-president, Section H, 1900; Frank Russell, secretary, Section H, 1900; J. Walter Fewkes, vice-president, Section H, 1901; George Grant MacCurdy, secretary, Section H, 1901; Mrs. M. L. D. Putnam, Frank W. Blackmar, G. A. Dorsey.

Member of Council, W. J. McGee. *Member of General Committee*, Mrs. W. S. Peabody.

Retiring Vice-president Butler's address, entitled, 'A Notable Factor in Social Degeneracy,' was delivered Monday afternoon. It was printed in SCIENCE of September 20.

The titles of papers presented before the Section are accompanied by brief abstracts in so far as it has been possible to secure these from the authors.

1. 'Exhibit of Curves of Speech': E. W. SCRIPTURE.

An exhibit of a series of plates containing the curves of vibration traced from a gramophone plate containing Rip Van Winkle's Toast spoken by Joseph Jefferson. In the absence of the author the paper was presented by Mr. MacCurdy. It will be printed in Scripture's 'Elements of Experimental Phonetics.'

2. 'Influences of Racial Characteristics on Socialization': FRANK W. BLACKMAR.

Racial characteristics are the great barriers that prevent a complete socialization of the human race; the race idea, or consciousness on the part of two groups of people that they are different in origin and structure is a detriment to perfect social union; a transition from the old family, or ethnographic, status to the modern, or demographic, society has been exceedingly difficult; the race idea has been the hindering cause in the progress of democracy; the historical examples of the social difficulties of Greece, Rome the Iroquois tribes and the Aztec federation; the difficulties of socialization appear in the development of homogeneous society in large cities; difficulties arising from an attempt to socialize widely divergent races; when common marriage relations are pro-

hibited by law, custom or prejudice the basis for social amalgamation is wanting; the inter-marriage of superior and inferior races results in an offspring inferior to the lowest of the united races. It is possible, however, through artificial selection, to unite the best elements of each race and hence raise the standard of the lower race. The variation in results from the inter-marriage of widely differentiated races as observed in the characteristics of the offspring.

It must be observed then, first, that a perfect social union is not possible between races that cannot intermarry; second, that intermarriage is not probable among widely divergent races if once included in the same social system; third, that intermarriage is not desirable between widely divergent races because controlled by lower sentiments and usually practiced by the lower elements, thus leading to degeneration; fourth, that race prejudice, so far as it prevents the union of widely divergent races, is good rather than evil. When different races, widely separated as to origin or widely divergent in culture, live under the same government, each must have its place; a government founded on justice must protect the weaker race and preserve its rights; examples from studies of the social and political status of the African race in America; examples from studies of the social and political status of the American Indians; a plea for a more careful study of races as a basis for socialization and a means for procuring rational legislation.

Discussion: Butler pointed out the necessity of understanding the psychic standpoint of a people in order to understand the influences of race or culture. McGee emphasized the invigorating influences of blood-blending when the stocks are not too greatly diverse, as shown, for example, by the British and American peoples, and then

mentioned culture as a factor of paramount importance in ethnic and demotic development. This paper was also discussed by Russell and Dorsey.

3. 'The Anthropological Collections of Yale University Museum': GEORGE GRANT MACCURDY.

An abridged statement relative to the size and character of the collections which, it is hoped, may be of service to students making a comparative study of museums of anthropology. They comprise from 15,000 to 18,000 specimens representing geographically thirty-six states and territories, Hawaii and the Philippines, besides forty foreign countries. The greater part of the material is archeological. The antiquities from Central America alone number over 3,000, including fifty-three gold ornaments from the Province of Chiriqui. The collection of Missouri pottery, more than 1,000 pieces in all, is one of the largest and best in the country. A representative series from the Quaternary and cavern deposits of western Europe, the Swiss Lake Dwellings, and the shell heaps and dolmens of Scandinavia has recently been installed. In respect to physical anthropology, the museum possesses several hundred crania, chiefly Amerindian, Hawaiian and New Guineaian.

4. 'Report on Work recently done by the Department of Anthropology, Field Columbian Museum': by the curator, GEORGE A. DORSEY.

Discussion: J. Walter Fewkes.

5. 'Political and Social Conditions in the Hawaiian Islands': DAVID STARR JORDAN.

6. 'Notes on Criminal Anthropology': AMOS W. BUTLER. A study of the individual family characteristics of inmates of the Indiana Reformatory. The results of four years of operation of the indeterminate sentence and parole law in that State.

7. 'The Nature of Sun Worship': J. WALTER FEWKES.

The two chief gods of the Pueblos are the sky god and the earth goddess. The sky god has a variety of names, some of which are the same as his attributes, as: wind, lightning, rain, etc.; others are simply clan names for the same god. The sun god is a being symbolized by the sun. The sun is a shield carried by the sky god. This sky god or sun god (the names are interchangeable) is the male principle—*i. e.*, the god of germs. His house is in the underworld. The female principle is the earth goddess, the goddess of germs. The god of fire was a god of life which practically originated as sky god. Differentiation came later. Inasmuch as the underworld was the home of the sky god and also regarded as the home of the dead, the sun as ruler of the underworld was regarded as the god of death. The sky god and earth goddess are personated by animal forms and the names of these animals are sometimes applied to them, *e. g.*, the sky god is often called the thunder bird. So the earth goddess is called the spider woman. Thus, in popular stories, they say the spider woman created man. Creation, as we understand it, is a foreign conception to primitive man; it is always akin to birth. The sky god and earth goddess are father and mother to all men, and animals as well. The earth is preexisting in their belief. Religious beliefs and practices are simply magical. Primitive man believes that everything has a magic power. The earth has magic power. The sky is regarded as a solid body and has its magic power. Every man, animal and object has its magical power, and the object of worship is to make use of this magical power to bring about desired results. For example, suppose a man wishes to bring rain. He owns certain fetiches whose magic power is great enough to compel the magic power of the sky to make it rain. He knows certain songs or prayers which will do the same.

He exerts this power in the form of a rite or ceremony.

8. 'Some Remarks upon the Attitude of the Citizens of the Southwest toward Archeology': FRANK RUSSELL.

A paper based upon observations made during an extended archeological reconnaissance in Arizona and adjoining territories. This research developed the fact that the average ranchman or miner takes an active interest in the antiquities of his locality, and usually formulates theories that are sometimes startling to the archeologist. The author also discussed the attitude of the Mormons, the extent of unscientific exploration and vandalism; besides relating personal experiences.

Discussion: Dorsey, Fewkes and Hewitt.

9. 'The Proposed Cliff Dwellers' National Park': EDGAR L. HEWITT.

The following is a summary of Mr. Hewitt's paper:

(a) The geological conditions of Pajarito Park, illustrated by photographs and an archeological map. (b) Nature and extent of the ruins thereon; illustrated by photographs of cavate lodges; ground plans of ruins known as Tchrega, Navakwa, Tsankawi and Otowi; maps of mesas on which these ruins are situated, and restorations in water-color of Tchrega and one section of cliff showing cavate lodges. (c) The pictography of the ancient inhabitants, illustrated by series of photographs from Puye and Pajarito. (d) Historical sketch of the movement providing for the setting aside of the Pajarito region as a national park. (e) Discussion of House Bill No. 13,071, known as the Lacey Bill.

Discussion: Blackmar, Fewkes, Dorsey and McGee. The last named emphasized the necessity of preservation of antiquities. He had drafted a general law for the preservation of antiquities on lands belonging to the United States. Had it passed, it would be easy to have states act on lands belong-

ing to them. The Public Lands Committee has recommended the setting apart of Pajarito Park as a national park to be called 'The Cliff Dwellers' National Park.'

One of the direct results of Mr. Hewitt's paper was the appointing of the following committee to draft resolutions on the preservation of the ancient monuments of the Southwest:

Edgar L. Hewitt, Chairman,
Amos W. Butler,
George A. Dorsey,
George Grant MacCurdy.

The report of this committee, after being accepted by the Section, was adopted by the Council and read in general session Friday morning.

10. 'Some Pawnee and Wichita Games':
GEORGE A. DORSEY.

Discussion: Russell, Culin, McGee and Fewkes.

11. 'The Teaching of Anthropology in the United States': GEORGE GRANT MAC-CURDY.

Information relative to the teaching of anthropology in our institutions of learning, collected at the request of the 'Committee on the Teaching of Anthropology in America.' It was found upon investigation that thirty-one universities and colleges now offer instruction in anthropology. They are: Beloit College, Beloit, Wis.; Bellevue College, Bellevue, Nebr.; Boston University; Brown University; Clark University; College of Physicians and Surgeons, Boston; Columbia University; Columbian University, Washington, D. C.; Creighton University, Omaha, Neb.; Dartmouth; Georgetown University, Washington, D. C.; Harvard; National University, Washington, D. C.; New York University; Niagara University, Niagara County, N. Y.; Phillips Academy, Andover, Mass.; Ohio State University, Columbus; University of California; University of Chicago; the Universities of Illinois, Indiana, Kan-

sas, Minnesota, Missouri, Nebraska, Pennsylvania, Vermont, and Wisconsin; Western Reserve University; Willamette University, Salem, Oregon; Yale University. Of the thirty-one institutions offering anthropology, it is found to be an adjunct of sociology in nine, of philosophy in five, of psychology in three, of geology and zoology in five, and of medicine in one; while in five instances it stands practically alone and in three it is unclassified.

Discussion: Blackmar, McGee, Dorsey and Farrell.

This paper will be printed in SCIENCE.

12. 'Current Questions in Anthropology':
W J MCGEE.

Discussion: Russell, Dorsey and others.

13. 'Analogy between Writing and Speech': ROBERT ARMSTRONG.

(a) All alphabetic characters are analogous, in (1) *material* and in (2) *function*, to the voice elements. (b) Written or printed letters have usually no analogy of character to the sound elements they represent. (c) Perfect analogy between graphic signs and spoken sounds is not attainable. But in proportion as alphabetic signs can be modeled from the sound elements they respectively represent, written or printed words will approach spoken words in character, and hence, in facility, economy and all that is desirable in written or printed words.

Charts were used in illustration of the subject.

14. 'Notes on the Archeology of Cuba':
STEWART CULIN.

15. 'The Problem of the Cliff Dwellers':
J. WALTER FEWKES.

A discussion of the relation of ancient Cliff Dwellers to modern Pueblos, showing a kinship in culture which does not, however, imply a kinship of blood. There was at least some kinship of blood. Some of the cliff houses in the Cañon de Chelly have been inhabited in historic times. There is a clan living now at Moki whose ancestors

once lived in the Chelly cañon. A very old woman of Moki still lives whose mother was born in a Chelly cañon cliff house. The cliff house may have been very old at that time, however. There are some very old cliff houses, while others are comparatively modern.

Discussion: Dorsey, Holsinger and ex-Governor Prince, of New Mexico. Governor Prince said the territory of New Mexico had offered the Old Palace in Santa Fé as a branch of the Smithsonian Institution.

A paper by J. Crawford on 'Sculptured Stone Images of Man by the Aborigines in Nicaragua,' and one by Charles E. Slocum, entitled, 'A Plea for Greater Simplicity and Greater Accuracy, in the Writings of the Future, regarding the American Aborigines,' were read by title.

On Tuesday, at 4 p. m., Section H adjourned to hear Mrs. John Hayes Hammond's lecture on 'The Cliff Dwellings of Colorado,' illustrated by lantern slides.

Dr. Fewkes's lecture Friday evening, on 'The Moki Snake Dance,' illustrated by lantern slides, was also of special interest to anthropologists, though not a part of the regular program.

A letter was read from Miss Alice C. Fletcher, who, in her enforced absence on account of illness, sent greetings to the Section; also a letter from Mrs. Daniel G. Brinton, to the effect that a new edition of 'The American Race' would appear in September of this year.

The report of the 'Committee on the Teaching of Anthropology in America,' which was read before Section H by Dr. McGee, was printed in SCIENCE of September 6, p. 353.

The report of the 'Committee on Anthropometric Measurements,' including the request for a grant of \$50, was recommended and later adopted by the Council.

Section H was authorized to hold a winter meeting, the time and place to be decided

upon by the Sectional Committee. The winter meeting will be held in Chicago during Convention Week of 1901-02.

The newly elected officers for the Pittsburg meeting are:

Vice-President, Stewart Culin, of the University of Pennsylvania.

Secretary, Harlan I. Smith, of the American Museum of Natural History, New York.

The invitation extended to Section H by Mr. and Mrs. Gilbert McClurg, of Colorado Springs, to inspect their cliff dwelling collection on Monday, September 2, was very generally accepted. The same week, a party of anthropologists visited the cliff dwellings of the Mesa Verde in southwestern Colorado as guests of the ladies of the Directorate of the Colorado Cliff Dwellings Association, of which Mrs. McClurg is Regent.

GEORGE GRANT MACCURDY,
Secretary of Section H.

EARLY WINTER COLORS OF PLANT FORMATIONS ON THE GREAT PLAINS.*

ONE who has not been upon the Great Plains in the early winter, after the autumn frosts have changed the prevailing green of the landscape, can have little conception of the variety of the colors which meet the eye. These include several shades of red, two or more of orange, one or more of yellow, two of green, a dark blue, a purple, several browns and blacks, and many grays. With a little practice the eye can distinguish from twenty to twenty-five shades of color, sometimes blending into one another almost insensibly, or standing out in marked contrast upon the landscape picture.

It does not require long study to show that so far as the natural vegetation is concerned these colors conform to the distribution of the various plant formations, and

* Read before the meeting of the Botanical Society of America, in Denver, August, 1901.

that we have here a natural color-scheme in which the plant formations are mapped on the landscape. Let me attempt to reproduce some of the color pictures I have seen.

First, give the picture a general gray tone, which may include the sky as well as the earth surface. In the background where the hills slope away to the horizon are great patches of dull red or purple, bordered by the silvery gray of the buffalo grass. Here in the foreground may be a stretch of light yellow marking the area of a field of maize stalks still standing where they grew, and there may be a gray, velvet-like meadow of buffalo grass, with dashes of brick-red now and then on its surface where the bunch grasses stand, or where the red stems of the knotweeds mark the winding course of a 'draw.' Here and there the landscape shows a black spot where the farmer has plowed up the rich soil in readiness for the spring's plantings. Crossing a ravine we find the sloping sides red with the bunch grasses, below which is a belt of yellow 'prairie grass' bordering the dry bed of the brook, the latter marked here and there with red-twigg'd willows. In the distance, where a stream winds its way along, is a black line of cottonwood trees, whose trunks and larger branches show black against the gray background, and on nearer approach we note the silvery sheen of their twigs contrasting with their dark stems and branches. A plum thicket in a ravine forms a dark-blue patch, with a background of dull red knotweeds, or bunch grass, further back shading into the silvery gray of the buffalo grass.

Now we see a silvery gray meadow of buffalo grass with faint patches of reddish color scattered over it; back of it a fringe of cottonwood and box elder trees with dark trunks, the latter loaded with their light brown fruits, and still back of these the slopes with alternating silvery gray patches of buffalo grass and the dull red of the

bunch grasses, running up to the sky line of light ochre where a field of maize is still standing. To complete the picture add a few stacks of alfalfa, now dark brown or black, and a spectral windmill here and there outlined in somber colors.

Allow me to show you one more picture seen near Minden, under the ninety-ninth meridian. Here is a little valley framed in with a brick-red border of bunch grass which grew on its sloping sides: next to it are patches of yellow switch grass and silvery gray buffalo grass, and a rich, velvety maroon spot where the ripe fruits of the smooth sumach give their color to the scene. The floor of the valley is covered with the red knotweed whose red is deepened in a central strip to a rich purple-red where a water course has encouraged the red-stemmed *Polygonums* to grow.

I need not attempt to place before you more of these general views. In all cases the picture has a basis of gray, and on this are laid reds, yellows, blues, purples, browns and blacks, etc. Let us inquire into the meaning of these strips and patches of color.

When the autumn drought and the early winter frosts stop the growth of vegetation the green shades of summer, themselves by no means uniform, are replaced by the hues indicated in the preceding paragraphs. The practiced eye can distinguish the plant formations on the open plains by their shades of green when the vegetation is in its vigor, and it appears that the early winter coloration is in a measure related to this fact. The boundaries of the formations are more sharply defined in the early winter, since the color differences are emphasized. I have not, however, been able to determine any law of color change in the plants of different formations. In fact it appears that each plant is a law unto itself. Thus the light green of the low bunch grass (*Andropogon scoparius*) gives place to a red,

as does the still lighter green of the tall knotweed (*Polygonum ramosissimum*), while the nearly similar pale green of the buffalo grass (*Bulbilis dactyloides*) turns to a silvery gray. On the other hand, the richer green of the switch grass (*Panicum virgatum*) turns to a red-orange below and a light yellow above, and the dark green of stinkweed (*Dysodia papposa*) as seen in the summer is replaced in early winter by a pronounced brick-red. Yet in the midst of these changes the clumps of dagger weed (*Yucca glauca*) and the bunches of cactus (*Opuntia humifusa* and *O. polyacantha*) retain their green color, and in fact, are the only green things in the landscape.

I may summarize the facts so far as I have observed them by grouping the plants under the colors they assume, as follows:

RED.

Bunch grasses (*Andropogon furcatus*, and *A. scoparius*).

The first (tall bunch grass) is sometimes of a rich orange-red running to dull red, and the second (low bunch grass) is from brownish red to brick-red and purple, fading out sometimes to a dull gray.

Knotweeds (*Polygonum ramosissimum* and *P. emersum*), with the stems of various shades of red, in the second species running to purple red.

Willows (*Salix fluviatilis*) with red twigs.

Stinkweed (*Dysodia papposa*), whole plant becoming brick-red.

ORANGE.

Bunch grass (*Andropogon furcatus*); as noted above, this species sometimes assumes a rich orange-red color.

Switch grass (*Panicum virgatum*) the lower portions of the seeding plants are often of a red-orange color.

YELLOW.

Maize fields during the autumn and early winter assume many shades, from the deepest yellow to a pale straw color.

Switch grass (*Panicum virgatum*); the upper portions of the seeding plants are often of a light yellow color.

GREEN.

Dagger weed (*Yucca glauca*) and prickly pear cactus (*Opuntia hemifusa* and *O. polyacantha*) constitute the only green vegetation on the plains in the winter.

BLUE.

Plum thickets (*Prunus americana*), seen at a little distance are distinctly of a dark blue color.

PURPLE.

Sumach fruits (*Rhus glabra*), ranging from a dull purple to a rich maroon-purple.

Low bunch grass (*Andropogon scoparius*), as noted above this species ranges from dull red to purple.

Knotweed (*Polygonum emersum*) although usually red, sometimes it becomes a purple-red.

BROWN.

Russian thistle (*Salsola tragus*), brown to blackish-brown, and the same may be said for weed fields in general.

Plum twigs (*Prunus americana*); although plum thickets when seen at a little distance are dark blue, the twigs when seen near at hand are reddish brown.

Box elder fruits (*Acer negundo*), light brown, and as they are very abundant they give the trees their color when seen near by.

BLACK.

Cottonwood tree trunks and branches (*Populus deltoidea*) seen at some distance are brownish-black to black.

Plowed land, burned areas and wagon trails all show black or nearly so on the landscape.

GRAY.

Buffalo grass (*Bulbilis dactyloides*), from a light or silvery green in the summer, this species changes to a light gray or silvery gray in the winter.

Grama (*Bouteloua oligostachya*), gray.

Beard grass (*Aristida* sp.) light gray.

Tickle grass (*Panicum capillare*), silvery gray.

Low bunch grass (*Andropogon scoparius*); as indicated above, this may fade out to a dull gray.

Cottonwood twigs (*Populus deltoidea*), grayish-white.

I may close this paper with a couple of sections observed between Oxford and Minden, Nebraska.

In the one case (Figs. 1 and 2) a ravine, with moderately abrupt but regularly sloping sides, was observed to have a central band

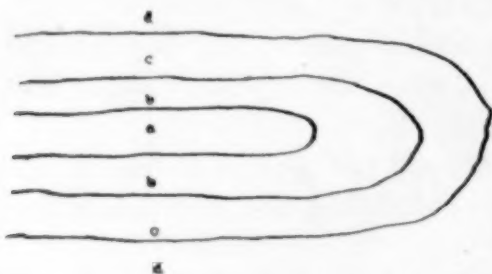


FIG. 1. Ground plan of ravine. *a*, yellow; *b*, red; *c*, gray; *d*, red.

(*a*) of yellow (switch grass) which occupied the entire floor. On each side was a belt (*b*) of red (bunch grass) which occupied the lower and more sloping part of the side of the ravine. On the shoulder of the ravine, running down to the more precipitous part and back to the edge of the level ground was a broader belt (*c*) of gray (buffalo grass and grama), and back of this again came the red of the bunch grass (*d*) which colored the general surface of the plain.



FIG. 2. Section of ravine; *a*, yellow; *b*, red; *c*, gray; *d*, red.

itous part and back to the edge of the level ground was a broader belt (*c*) of gray (buffalo grass and grama), and back of this again came the red of the bunch grass (*d*) which colored the general surface of the plain.

In another case (Fig. 3) a gentle slope with somewhat terraced surface was ob-

served with a peculiar distribution of color. There were three steps on the slope, each not more than twenty to thirty centimeters



FIG. 3. Section of terraced slope; *a*, *a*, *a*, red; *b*, *b*, *b* gray.

in height, and a couple of meters apart, the surface sloping gently from step to step. On each terrace the upper edge near the step (*a*) was red with bunch grass, while the lower portion (*b*) was gray with Buffalo grass and grama. This was repeated exactly upon each terrace, giving the whole view a very singular appearance.

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RUDOLPH KOENIG.

On the second day of October, 1901, Rudolph Koenig passed away at his home in Paris in his sixty-ninth year. He had been in failing health for several years.

Rudolph Koenig was born in Koenigsberg, Prussia, on the 26th of November, 1832. At his home he received nothing beyond the usual high school training given in the local gymnasium, in which his father was the teacher of mathematics and physics. He went to Paris at the age of nineteen years, and in the French metropolis he spent most of his manhood. Here he began life as an assistant in the manufactory of a celebrated violin maker, Vuillaume, where he manifested unusual aptitude both as a mechanic and as the possessor of an extraordinarily delicate and correct ear for music. Such leisure as he could command was devoted to the study of mechanics and physics.

Within a half-dozen years the young acoustician was enabled to undertake business on his own account, having already attracted the notice of men of science by his ingenuity, patience and accuracy. In 1859 he issued his first catalogue of acoustic

apparatus. From that day to the present Koenig's instruments, and especially his tuning forks, have been generally recognized as standard.

Koenig was not satisfied to fill orders and maintain his reputation as a constructor of instruments. He early perceived the value of the graphic method for the study of harmonic motion, and to this he devoted much time and labor during the first few years after establishing himself independently. Wertheim and Duhamel had already used the tuning fork with style attachment for the registration of simple vibrations, as suggested a half century previously by Dr. Thomas Young in England. Koenig extended it to the study and registration of compound harmonic motion for both parallel and rectangular vibrations. The mathematical analysis of wave motion had been abundantly brought out in technical treatises, and Lissajous had but recently excited admiration by his optical method of presenting rectangular vibrations. Koenig devised the method of recording these directly from the sounding tuning fork. At an international exhibition held in London in 1862 he exhibited an album containing a large variety of such phonograms, recorded with apparatus of his own device, and accompanied with the tracings of the corresponding theoretical curves. This was the starting point for the use of the graphic method of self-registration which has since been so extensively employed in laboratories of physics, physiology and psychology.

It was at the same exhibition that Koenig made known a wholly new method of causing the effects of sonorous vibration to become visible by utilizing the delicate sensitiveness of flame to variations of atmospheric pressure. The suggestion had come from America, where Le Conte had published, in 1858, his observations on the effect of sound waves upon naked gas flames.

Koenig devised the manometric capsule, and resorted to Wheatstone's application of the revolving mirror for spreading the flame images. The last improvements on this method have been made by the application of instantaneous photography to perpetuate the images, some of the best of this work having been done within the last few years by Hallock in New York and Merritt in Ithaca. The manometric flame is not equal to the tuning fork curve as a means of studying the composition of vibration, but the novelty and attractiveness of the method quickly made its author famous. He received a number of medals, and in 1868 the honorary degree of doctor of philosophy was conferred upon him by the university of his native city, Königsberg, in acknowledgment of his meritorious original work in science.

Prior to 1882 Koenig had published about sixteen scientific papers, some in the *Comptes Rendus*, but most of them in the *Annalen* of Poggendorff and Wiedemann. These were gathered into a volume entitled, 'Quelques expériences d'acoustique.' Since that time he has published a number of contributions to *Wiedemann's Annalen*, the last of which appeared in the summer of 1899. Failing health had already put a check upon his activity, but his passion for experimental research continued long after the time when most men lose their enthusiasm for abstract investigation. All his research work was the outcome of the love of science without the promise of pecuniary reward. It was done, moreover, with full knowledge that as a branch of pure science acoustics had been forced to the background by such subjects as heat, and more especially electricity, in which the field has become widened almost without limit during the last two or three decades.

In the absence of systematic university training in early manhood Koenig as an investigator in physics was compelled al-

ways to work at some disadvantage. He had an abiding faith in experiment, and was not afraid to proclaim the results of his careful, painstaking work, even if it seemed to contravene the conclusions of those whose theoretic preparation was better than his. The subject of musical quality was one which he attacked with characteristic patience. With the mathematical theory of combination tones, as brought out by Helmholtz, and the two subdivisions of difference tones and summation tones, Koenig was not prepared to grapple. With his naturally acute and highly trained ear he sought in vain to perceive the summation tones for which theory provided, and he reached the conclusion that they had no objective existence. Difference tones, or beat tones, as he called them, are easily perceived, and he spent much time in the investigation of such tones due to the interference of upper partials. It was in furtherance of this investigation that he invented the wave siren; and as a result of experiment with it he concluded, in opposition to the view of Helmholtz, that musical quality is determined not only by the number, the orders and the relative intensities of the upper partials which accompany a given fundamental tone, but also by their mode of phase combination. To test this the wave siren was certainly better than the apparatus employed by Helmholtz; but the perception of the result requires an experienced ear. The experiment is more psychological than physical. Upon the present writer, while cooperating with Koenig in his laboratory, and upon others also, the decided impression was that Koenig's conclusion was correct. But the subject is still one for investigation.

A monumental piece of mechanical work accomplished by Koenig was his great tonometer, consisting of hundreds of accurately adjusted and properly labeled

tuning forks arranged in a series, each making a definite and small number of beats with the preceding and following ones, so that the frequency of any source of sound approximately simple can be at once ascertained by direct comparison. The range extends through all the tones ordinarily employed in music. To have access to this tonometer the late Professor A. M. Mayer spent the summer of 1892 in Paris, where he secured the cooperation of Koenig in his research on the variation of the modulus of elasticity of different metals with change of temperature, as indicated by the pitch obtained by transverse vibration of bars. Koenig's keen ear was applied also in Mayer's investigation regarding the duration of the residual auditory sensation when beats are produced by neighboring tones in different parts of the musical scale. The author's conclusion was that, between the limits of 100 and 4,000 vibrations per second, there was closer accordance between the results of calculation and observation than in the case of any other physiological law for which the attempt had been made to express sensation mathematically. So well trained was Koenig's ear that in the tuning of the standard forks issued from his laboratory there was little need for any better guide than his own auditory sensation. After the pitch had been provisionally attained in this way it was corrected by other and more exact methods, but the correction was always very small.

It seems scarcely probable that Koenig will have any successor. For a man now to devote his whole life to the science of acoustics would be a piece of specialization for which but little reward can be expected. The progress of science has its phases of relative importance and that of acoustics seems now to be past. Koenig is dead, and his friends will remember him with affection and respect. His devotion to acous-

tic science was unique. His life was that of the recluse bachelor, and his later years brought anxiety and privation because his science had lost its value as a means of support. He will not soon be forgotten; but likewise no one will aspire to take his place.

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SCIENTIFIC BOOKS.

1. *Hygiene and Public Health.* By LOUIS PARKES, M.D., D.P.H., London University, and HENRY KENWOOD, M.B., D.P.H., F.O.S. Sixth edition, 1901. Philadelphia, Pa., P. Blakiston's Son & Co., publishers. With numerous illustrations. Pp. 732. Price, \$2.50.
2. *The Theory and Practice of Military Hygiene.* By EDWARD L. MUNSON, A.M., M.D., Captain, Medical Department, U. S. Army. First edition, 1901. New York, Wm. Wood & Company, publishers. Illustrated by eight plates and nearly four hundred engravings. Pp. 971. Price, extra muslin, \$8.00; leather, \$8.75.
3. *A Manual of Practical Hygiene*, for students, physicians and medical officers. By CHARLES HARRINGTON, M.D., Assistant Professor of Hygiene, Medical School of Harvard University. First edition, 1901. Philadelphia and New York, Lea Brothers & Co., publishers. Illustrated with twelve plates and one hundred and five engravings. Pp. 729. Cloth, \$4.25 net.
4. *The Principles of Hygiene*; a practical manual for students, physicians and health officers. By D. H. BERGEY, A.M., M.D., First Assistant, Laboratory of Hygiene, University of Pennsylvania. Philadelphia, W. B. Saunders & Co., publishers. Pp. 495. Price, cloth, \$3.00 net.
5. *School Hygiene.* By EDWARD R. SHAW, Professor of the Institute of Pedagogy, New York University. First edition, 1901. New York and London, The Macmillan Company, publishers. Pp. 260. Price, cloth, \$1.00.

In view of the fact that hygiene is not an independent science, but a correlation of the

teachings of physiology, chemistry, physics, meteorology, pathology, epidemiology, bacteriology and sociology, it is not surprising that the progress of this branch has been phenomenal. Over twenty text-books have been issued during the last ten years, and all but Parkes's in the above list are products of the present year. Indeed, this science was scarcely taught in any of our medical schools twenty years ago, and has received such an impetus during the past two decades that many regard it of modern origin. Such, however, is not the case, for on turning to early history, we almost invariably find that the health of the population has been made the subject of legislation. Hygiene was practiced by the Egyptians, the old Indians and Hebrews, and a study of the habits of the primitive peoples shows that a desire to prevent disease is innate to all men. The Greeks and Romans paid special attention to the physical culture of their youth, public water supplies and baths, and Athens and Rome were provided with sewers at an early period of their history. During the Middle Ages sanitation received a decided check; ignorance and brutal prejudices appear to have been the ruling spirits, and for many reasons it was the most unsanitary era in history. About this time most of the towns in Europe were built in a compact form, surrounded with walls; the streets were narrow and often winding for defensive purposes, shutting out light and air from the houses. The accumulation of filth was simply frightful. Stables and houses were close neighbors, human filth was thrown on the streets or manure heap. The dead were buried within the church-yards. Sewers and aqueducts having been permitted to fall into disuse, the inhabitants were compelled to resort to wells with polluted subsoil water. All the conditions were favorable for the spread of infectious diseases, and in the fourteenth century alone the oriental or bubonic plague, according to Hecker, carried off one-fourth of the population of Europe. The mortality in towns was greater than their birth rate, and the city population until the close of the eighteenth century had to be recruited continually from the country. The repeated invasion of pestilential diseases, however, compelled everywhere some sanitary efforts in the way of

widening streets for the purpose of supplying more air and light to habitations, better methods for the collection and removal of the wastes of human life, improvement in connection with infant and orphan asylums and in the management of schools and prisons.

The nineteenth century can boast of many advances in hygiene, particularly since the European invasion of cholera in 1830. English towns which had been visited by this disease, and those fearing similar scourges, freely instituted sanitary reform in the establishment of sewers, public water supply, sanitary homes for wage-earners, etc., but even during the Crimean War, the medical officers of the army evinced a shameful ignorance of the principles of sanitation and induced Edmund A. Parkes to write his manual of Practical Hygiene, and his teachings have borne ample fruit, especially in the improvement of the air we breathe and the water we drink. The question, has human suffering been mitigated and human life greatly prolonged by efforts in sanitation, can be emphatically answered in the affirmative. The average length of human life in the sixteenth century was only between 18 and 20 years; at the close of the eighteenth, it was a little over 30 years, while to-day it is over 40 years. Indeed, the span of life since 1880 has been lengthened about six years, as shown by statistics in Mulhall's Dictionary of Statistics (4th Edition, London, 1899). Mr. William A. King, Chief Statistician in the U. S. Census Office, informs the writer that from the results of the mortality returns for the twelfth census, for the States in which the returns were secured from registration records in both 1890 and 1900, there appears to be an absolute decrease in the general death rate of about 1.8 per 1,000 of population. This decrease seems to be most marked in the rate due to scarlet fever, whooping-cough, diphtheria and croup (combined), typhoid fever, malarial fever, consumption, diarrheal diseases and diseases of the nervous system, the decrease in the mortality in diphtheria and croup amounting to more than 50 per cent. On the other hand, the rate due to cancer and tumor (combined), Bright's disease, heart disease and dropsy (combined) and pneumonia is apparently greater than in 1890, the increase be-

ing most marked in the case of Bright's disease, cancer and tumor and pneumonia. The results in the decreased rate of diphtheria, croup, scarlet fever, typhoid fever, whooping cough, consumption, malarial fever and diarrheal diseases are the direct outcome of preventive medicine and are as gratifying as they are striking. We note with regret the increased rate in Bright's disease, heart disease, dropsy and pneumonia, and may well pause to inquire whether our ever-increasing annual 'national drink bill,' averaging 17.68 gallons per capita, may not be a factor in the development of these diseases, especially since there is reason to believe that the habitual and immoderate use of alcohol, apart from increasing the connective tissue and causing cirrhosis, also produces fatty degeneration, especially of the heart, liver and arterial coats, probably because it promotes the conversion of albuminoids into fats. Since our knowledge of the nature of infectious diseases has been more and more defined, scientific methods for their prevention have been applied. We have learned, too, that in addition to the germ there must be a suitable soil for its proliferation, and that sanitation will not only destroy the environments for its development without the body, but also place the system in the best possible condition to resist its toxic action. The application of this knowledge has saved millions of lives, besides an incalculable amount of human suffering and distress, not to mention the economic aspect of the question. When we remember all this and the fact that Jenner's discovery, at the close of last century, of a fundamental and practical method of producing artificial immunity has been far eclipsed in the last 20 years, and that we possess to-day not only curative but also protective sera for diphtheria, erysipelas, tetanus, plague and possibly cholera, tuberculosis, typhoid fever, pneumonia and a number of other immunizing agents for diseases of man and the lower animals, we have reason to believe that the solution of the problem of immunity is only a question of time and we may indeed expect great possibilities in our battle against infectious diseases. Great as our progress has been, much remains to be done. While every scientific physician familiar with biological research knows full well that if the

methods of prevention recommended by sanitarians, including the prompt disinfection of the dejecta of every typhoid fever patient, the expectoration and excretion of diphtheria and tuberculosis patients, for example, were adopted, these diseases would be reduced to a minimum and probably eradicated in the course of a few years. The facts are, these recommendations have not been generally adopted, because the knowledge gained by experimental medicine is not sufficiently diffused even among physicians. We hail, therefore, with special delight the appearance, in 1901, of five American text-books on this important subject. Dr. Louis Parkes's book is the sixth edition of a very popular text-book, in both England and America. It contains 12 chapters on water; the collection, removal and disposal of excretal and other refuse; air and ventilation; warming and lighting; soil and building sites; climate and meteorology; exercise and clothing; food, beverages and condiments; communicable diseases and their prevention; hospitals; disinfection; statistics; sanitary law and administration. The work is authoritative, and until the appearance of the American Text-books, by Rohé, Egbert and Coplin, enjoyed great popularity in our medical schools.

Dr. Munson's royal octavo volume of 948 pages is the best work in the English language on military hygiene. He has handled the subject in a masterly style. His literary skill, thoroughness and painstaking research, practical experience and expert knowledge of sanitary chemistry have combined to produce a treatise of rare merit. The work is divided into 27 chapters, and, in addition to the subjects treated of by Parkes and other authors in the general principles of hygiene, deals, of course, also with the selection and development of the recruit, the march in campaign, camp sites, the sanitary administration of the camp, post barracks and hospitals, diseases of the soldier, military mortality and morbidity, the habits of a soldier as affecting his efficiency, the hygiene of hot and cold climates, the hygiene of the troop-ship, etc.

Every chapter in the book is encyclopedic in character and contains a mine of the latest information of great value not only to the student of military hygiene, but to the general student

as well. So, for instance, the chapters on the selection and development of the recruit are of equal importance to those interested in personal hygiene and physical training. The chapter on water contains 150 pages, and is in many respects superior to the standard works exclusively devoted to the consideration of this important requisite. The chapter on the ration with his article on food in the hygiene of hot and cold climates covers over 160 pages and is practically a comprehensive treatise on food, dietaries, the preparation and preservation of food and its relation to health and disease. It contains facts not to be found in any other work.

The chapter on camp sites and the sanitary administration of camps is most admirably disposed of. Had the knowledge contained therein been more generally diffused among medical men and especially among the officers of the line, the disgraceful unsanitary scenes of our military camps during the recent Spanish-American war would not have been observed.

Chapter XV., on diseases of the soldier, is of extreme interest, especially the consideration of infective diseases, such as typhoid fever, which the author very properly considers as being the most important disease affecting soldiers. It is to be regretted that the lessons of the civil war and the note of warning sounded by Surgeon-General Sternberg at the outbreak of the Spanish-American war had made so little impression upon those entrusted with the care of our troops.

The chapter on excreta, sewage and refuse is very complete. The author's conclusion that typhoid cases are much more numerous in communities where fecal matters are collected in pits, pails, earth closets, etc., than among those provided with water-closets and sewers, was emphasized by the writer in his report on the prevalence of typhoid fever in the District of Columbia in 1895, and a probable explanation was offered by him in stating "these makeshifts, even if there were no wells, are still a source of danger in so far as they favor the transmission of germs by means of infected flies, nor can the possibility be ignored that the germs in leaky or overflowing boxes may reach the upper layer of the soil and with pulverized dust gain access to the system." It is a matter

of regret, therefore, that while 41 per cent. of our population live in towns having public water-supplies, only 28.7 per cent. are supplied with sewers, the neglect of which compels recourse to these makeshifts and leads to soil pollution and the evils referred to.

Space will not permit the presentation in detail of all the salient features of this excellent treatise. Our experience in the past shows the absolute necessity of sanitary training on the part of officers of the line. This work should be in the hands of every officer in the army and accessible to every enlisted man. We also venture to express the hope that a chair of hygiene will be created in connection with the military and naval academies. Such a step with men like Dr. Munson as professors would prove of incalculable value to the nation; indeed, the principles and practice of hygiene should be taught in every high school and college of the land, for nothing will contribute more to the sum total of human happiness than the preservation of health and eradication of preventible diseases.

Professor Harrington's manual is also complete, authoritative, practical and modern. It is divided into seventeen chapters, and we are pleased to note that a chapter on the 'Hygiene of Occupation' has been introduced and disposed of in a very satisfactory manner. The relations of occupation to health and life were studied as early as 1700 by Ramazzini, an Italian physician, and since then numerous monographs have appeared. We know to-day that persons habitually engaged in hard indoor work present a higher mortality than persons more favorably situated, and that the character of occupations influences to a great extent not only the average expectation of life, but also the prevalence of certain diseases. We know, for example, that tuberculosis is much more frequent among persons engaged in dust-inhaling occupations, and that the sharp angular particles of iron and stone dust are more liable to produce lesions of the respiratory mucosa than coal, flour, grain and tobacco dust. We know, too, that certain establishments are more or less productive of noxious and offensive gases, and that workers in lead, mercury, arsenic, phosphorus, poisonous dyes, etc., suffer especially from the injurious effects, and that other occu-

pations, such as mining, railroading and contact with moving machinery involve special danger to life and limb. For all these reasons the laboring classes need special protection, and in order to render this efficient, it must be provided by the enactment and enforcement of suitable laws. In 1864, 1867 and 1878, England enacted the so-called factory laws, while the first law as regards factory safety and sanitation in this country was enacted in Massachusetts in 1877, since which time 32 states have enacted similar laws. As a result of these laws, the majority of which were enacted during the past decade, commendable progress has been made in the way of ventilation, heating, lighting, removal of dust and injurious gases, means of escape in case of fire and prevention of injuries by moving machinery.

Dr. Harrington is quite right in saying: "It is often difficult or impossible, in the study of the effects of occupation, to eliminate outside influences which may affect the health of the worker as much or more than the circumstances of his trade. A hundred men, for example, from different strata of society, some married, others single; some living in comfortable houses, others in cheerless unsanitary tenements; some spending their evenings in wholesome recreation amid wholesome surroundings, others doing evening work in places of public entertainment and elsewhere, or spending their time and wages in the paths of vice; some naturally robust, and others inclined to disease, engage in the same occupation at the same time."

The writer has always felt that these and other factors, such as faulty nutrition, the result of badly prepared food and cold lunches, cannot fail to lower the power of resistance to disease, especially when the individual, in consequence of these very causes, has also become a victim of the alcohol habit, and has advocated the erection of sanitary homes for wage earners at reasonable rentals, the encouragement of cookery schools, the establishment of sanitary lodgings, model eating-houses and other betterments of industrial conditions. Dr. Harrington's book is well illustrated and will meet the needs of the student.

Dr. Bergey's book has just appeared and has been prepared, in the author's language, 'to

meet the needs of students of medicine in the acquirement of knowledge of those principles on which modern hygienic practices are based; to aid students in architecture in comprehending the sanitary requirements in ventilation, heating, water supply and sewage disposal, and to aid physicians and health officers in familiarizing themselves with the advances made in hygienic practices in recent years.' The volume, while not exhaustive, is accurate and will meet the demand in a very satisfactory manner. We regret, however, that neither this book nor Harrington's volume refers to the important subject of sexual hygiene and the prevention of venereal diseases, which affect not only the offender, but innocent wives, the offspring and not infrequently other innocent persons. According to Fournier, one-seventh of the population of Paris is syphilitic, and Morrow, from statistics gathered in New York, believes it is quite possible that Fournier's figures may apply to New York. Neisser holds that gonorrhea is, with the exception of perhaps measles, the most widespread of all diseases. Other authorities have computed that 80 per cent. of all deaths from disease of the uterus and its annexes are of gonorrheal origin, while according to Professor S. M. Burnett, of Georgetown University, 15,000 of the 50,000 blind persons in the United States lost their sight from blenorhea in the newborn, which, according to his calculation, involves a financial loss to the commonwealth of seven and one-half millions annually.

The measures which have been proposed for the control of the social evil and the prevention of its consequences are numerous enough, but not so easy of practical application. On the whole, it is believed that the remedy lies in public education. Public lecturers on the purity of man commit a serious mistake, however, when they picture the consequences of the social evil, without offering a suitable remedy. We should make a strong plea in favor of continence, and tell our young men that while the sexual passion is very strong, it can be accelerated or delayed, excited or lowered, by the influence of the will. We should assure them that by the cultivation of pure thought, removal of temptation, normal

mental and vigorous physical exercise, continence may not only become possible, but easy.

None of the books in the above list will fulfill a more important mission than the modest volume on *School Hygiene*, by Professor Edward R. Shaw, of the New York University. It is a timely book belonging to the Teachers' Professional Library series, and it is hoped it will enjoy a wide circulation, because, as the author very properly says, "The home may be educated to a great extent through the school. As the school, therefore, reacts closely upon the home, a knowledge of that which is hygienically best can in no other way be so quickly and thoroughly diffused."

The chapters treat of the school room, the school building, school grounds, warming and ventilation, sanitation, school baths, school furniture, posture and physical exercise, eyesight and hearing, handwriting, conditions conducive to healthful mental work, and diseases which concern the school. Every chapter is replete with information of great value and should be thoroughly absorbed by architects, school boards, teachers and parents. The book is accurate and reliable and the style clear and convincing.

During the year ending June 30, 1900, there were 15,341,220 children enrolled in the common schools of our country. When we consider that the mental and physical vigor of a nation depends largely on the environments of childhood and youth, it seems strange that up to within forty years little or no attention should have been paid to the hygiene of schools.

The author treats this important subject in a systematic and comprehensive manner, and no one can overestimate the practical results of his valuable teachings. Chapters IV. and V. are especially important, treating as they do of warming, ventilation, latrines, out-houses for country schools, plumbing, water supply, drinking-cups, daily cleaning of the school building, the cleaning of desks and seats, the disinfection of pencils and books, etc. Chapter VI., on school baths, should attract widespread attention, and shows what has been done in Europe, where the idea originated, and also in Boston, New York, and Chicago. According to the author, two distinct aims are held in view in the

provision which is made by school systems for bathing. The first aim is for physical exercise and health; when this is the aim a swimming tank is provided. * * * The second aim is to produce cleanliness and to teach cleanliness. The most satisfactory means to attain the second aim seems to be that of the shower-bath. In some schools a bath-tub is employed, but this cannot be used as economically in regard to time as the shower-bath; it must also be cleaned after each using. It will be understood, of course, that dressing rooms are necessary in connection with the baths. * * * The testimony of those who, under the conditions above mentioned, have instituted school baths is strong with reference to the physical and moral results arising therefrom. * * *

The writer is strongly in favor of swimming tanks in all high schools; such baths, after an ordinary cleansing shower bath, apart from bringing into play every muscle of the body, exert a general tonic effect and could be thrown open in the afternoons and evenings to adults, and thus subserve the purpose of public baths, of which there is a lamentable lack.

The chapter on eyesight and hearing is especially strong and suggestive of good results. The author, after referring to proper and sufficient lighting of the school room, points to the interesting investigations of Iaval, Cattell and Sanford, how vision may be impaired by texts printed in too small letters, the alterations needed in the forms of letters, the proper size of type for school books, color and surface of the paper for school books, the size of writing on the blackboard, the objection to the use of slates, color of writing ink, postures, use of fine maps, duty of parents in preventing children at home from reading excessively at night, or in the waning light, or sewing with black thread on black cloth with defective illumination.

The author's views on defective hearing are also extremely sound when he says, "if we are to educate children, it is supremely wise to know as many of their physical defects as possible, and especially is this true as regards defects of the two most important avenues of sense, the eye and the ear; for only by means of this knowledge can the teacher work intelligently and avoid unnecessary strain on the part

of the pupil and waste of effort on his own part. Careful investigations point to the broad fact that about 20 per cent. of school children possess some defect of hearing. It will be seen that the child of average ability who has some undetected defect of hearing will frequently be done an injustice and rated as dull or inattentive, not through any fault of his own, but because of a lack of knowledge on the part of the teacher of the true cause."

These abstracts sufficiently indicate the thoroughness which characterizes this most useful book.

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Manual of the Flora of the Northern States and Canada. By NATHANIEL LORD BRITTON, Ph.D., Director-in-Chief of the New York Botanical Garden; Emeritus Professor of Botany in Columbia University; Vice-President of the New York Academy of Sciences. New York, Henry Holt and Company. 1901. Duodecimo. Pp. x + 1080.

The appearance of a new manual of botany is an event of no small moment when it comes from the hand of one recognized as an authority in systematic botany. The 'Illustrated Flora of the Northern United States, Canada, and the British Possessions,' by Dr. Britton and Judge Brown, in 1896-7-8, marked an epoch in North American botany, and at once created an imperative demand for a handy field manual in the form of an abridgment of the large work. It is to meet this demand that the work before us is intended. In its preparation Dr. Britton has availed himself of the descriptions in the 'Illustrated Flora,' which are transcribed with little or no modification excepting the necessary one of changing English to metric measurements. Many species not described in the 'Illustrated Flora' are added, and not a few genera, bringing the total number of species to about 4,500 as against 4,162 in the original work. When we remember that the latest edition of Gray's 'Manual' contained descriptions of 3,298 species, and Coulter's 'Manual,' 1,881 species, it is evident that the utmost brevity has been imperative. Abbreviations are freely

used, although not to the extent so familiar in similar German manuals. Practically all synonyms are omitted, and this, while inconvenient for some users of the book, is no doubt the better policy in a compact manual. In this the author follows the wise example of Gray's 'Manual.' Synonymy, with all its confusing difficulties, need not be brought to the beginner's notice, and for the older botanist, anything short of full citations (impossible in such a manual) is of little or no use.

Students will be interested in noticing that 'Order' and 'Family' are not identical groups, but that they stand in their proper relation in this book, as in zoological manuals. The full citation of authorities for species, including double citation where necessary, and the citation of the author of each family name, are welcome novelties in an American botanical manual. As to the nomenclature used, the statement is made in the preface that "the principles adopted by the botanists of the American Association for the Advancement of Science at a meeting held in Rochester, N. Y., in 1892, and in Madison, Wis., in 1893, supplementary to the Code of Nomenclature adopted by the International Congress of Botanists held in Paris, France, in 1867, have been followed." Accordingly, we have here a manual in which the much-discussed 'Rochester Rules' are in force, and from this time forward young botanists will be taught this nomenclature from the first. There will henceforth grow up a generation of botanists for whom the names here given are orthodox.

This book must at once find its way into the schools and colleges, to which it may be commended for the students in systematic botany.

It remains to be said that the publisher has met and successfully solved the difficult task of bringing so large an amount of matter within the compass of a book not too large for easy carrying into the field. It might easily have been made still smaller and lighter by the use of still thinner paper, and a little closer trimming of the margins. As compared with the pocket edition of Gray's 'Manual' this is a much larger and heavier book; if printed on the same paper and trimmed as closely, this book would weigh but twenty ounces, instead of thirty as

it does now. We suggest that in future editions the printer and binder try to make some improvement in this respect.

CHARLES E. BESSEY.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for October contains the third and concluding part of W. M. Wheeler's 'Compound and Mixed Nests of American Ants,' the three forming an excellent compendium of our knowledge on the subject. Bashford Dean presents some interesting 'Notes on Living Nautilus' and Charles C. Adams has an article on 'Base-leveling and its Faunal Significance,' with illustrations taken from the topography and distribution of mollusks in the southeastern United States. The balance of the number is taken up with numerous reviews of scientific literature.

The Journal of Comparative Neurology for October. 'The Cranial Nerves and Cutaneous Sense Organs of the North American Silurid Fishes,' by C. Judson Herrick. This is a detailed exposition of the components of the cranial nerves of the catfish and of the structure and innervation of the cutaneous sense organs. Of the latter there are four types, three classed as neuromasts (Merkel's *Nervenhügel*) and one as terminal buds (*Endknospen*), the former innervated by lateralis nerves, the latter by communis. 'The Psychological Theory of Organic Evolution,' by H. Heath Bawden, is an attempt to put some meaning into the term mental evolution without falling into the error of talking about unconscious mental states. Natural selection may in some instances be a survival of the fittest among accidental variations, but in many cases natural selection takes place in and through the conscious adaptation of means to ends. The condition of consciousness is organic tension. The evolution of consciousness has followed the path of critical stress in adaptation of organic forms. Hence the criterion for the presence of consciousness is not simply adaptation of means to ends, but adaptation under conditions of organic tension, *i. e.*, the ability to vary the use of means in the attainment of an end.

The Popular Science Monthly for November has for frontispiece a portrait of Charles Darwin

and the first article is taken from the *Journal of the Linnean Society* for 1858, being the now historic paper 'On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection' by Charles Darwin and Alfred Wallace. A. E. Verrill tells 'The Story of the Cahow' an unknown and probably extinct bird found abundantly on the Bermudas at the time of their discovery. The use of the bird and its eggs for food was the cause of its speedy extermination. Under the caption 'Psychiatry—Ancient, Medieval, Modern,' Frederick Lyman Hills gives a brief history of the methods employed for the treatment of the insane from early times to the present. John E. Gorst makes a plea for 'The National Control of Education' and Edward L. Thorndike discusses 'The Evolution of the Human Intellect.' Bradley Moore Davis considers 'The Origin of Sex in Plants' and David Starr Jordan has a brief article on 'The Fishes of Japan' with observations on the distribution of fishes. Paleontologists will hardly accept Dr. Jordan's three laws governing animal distribution as all-sufficient. The final paper is by A. C. Haddon on 'The Omen Animals of Sarawak' and contains much interesting information.

The Auk for October opens with a welcome article by William Brewster entitled 'An Ornithological Mystery' describing the notes and nest of a bird found in the vicinity of Cambridge, Mass., which so far has not been seen, but is presumably the little black rail. A. C. Bent describes, with photographs, the 'Nesting Habits of the Anatidæ in North Dakota' and Arthur H. Howell gives 'A Preliminary List of the Summer Birds of Mount Mansfield, Vermont,' including 86 species. J. A. Farley tells of the 'Alder Flycatcher (*Empidonax trailii alnorum*) as a Summer Resident of Eastern Massachusetts,' and Outram Bangs has a paper 'On a Collection of Birds made by W. W. Brown, Jr., at David and Divala Chiriqui' including descriptions of several new species and subspecies. Hubert Lyman Clark treats of 'The Classification of Birds,' as based on their pterylosis, an excellent paper, but one which will impress many as an additional piece of evi-

dence that birds may not be classified by one character only. William Alanson Bryan gives a 'List of the Hawaiian Birds in the St. Louis College Collection, Honolulu, H. I.,' and finally, Francis J. Birtwell describes the 'Nesting habits of the Evening Grosbeak (*Coccothraustes vespertinus*).' The notes and reviews are numerous.

Bird Lore for September-October has a frontispiece showing the fine 'Bird Rock Group' of sea birds recently placed on exhibition in the American Museum of Natural History. H. W. Henshaw concludes his 'First Impressions of Hawaiian Birds,' Ralph Hoffman tells of 'A Chebic's Second Brood' and we have the regular instalment of 'Birds of the Season,' discussing the bird life of October and November in various parts of the United States. For young observers we have an account by A. V. Kidder of 'A Bittern at Close Range,' and we have Notes from Field and Study, Reviews, and the section devoted to 'The Audubon Societies.'

The Plant World for September has articles on 'Notes on Trees of Cuba,' by Valery Havard, a biographical sketch of the late 'Dr. Charles Mohr,' by S. M. Tracy; 'The Pasque Flower,' by John M. Holzinger, and many interesting briefer items. The instalment of the 'Families of Flowering Plants,' by Charles L. Pollard, continues the description of various families of the order *Sapindales*.

Popular Astronomy for November continues the study of the light curve of the new star in Perseus, by Dr. H. C. Wilson, and includes a chart of this curve which has been compiled with great care from many sets of observations. Dr. Lewis Swift, who has but recently given up the directorship of Mount Lowe Observatory on account of failing sight, permits the publication of a photograph of his various medals. This is accompanied by a brief résumé of his life as an astronomer, and of the discoveries for which the medals were awarded. Dr. T. J. J. See, of the Naval Observatory, contributes 'Preliminary Investigations of the Probable Diameters, Masses and Densities of those Satellites which have Measurable Discs,' and W. F. Denning, of England, writes of 'The Motion of the Great Red Spot and other

Markings on Jupiter.' Other articles are: 'The Astronomy of the Nebulæ,' by W. W. Payne; 'The Coming Opposition of Eros,' by Mary Clark Traylor; 'The Limits of Vision,' by Edwin Holmes, and 'The Brightness of Star Light,' by J. E. Gore.

DISCUSSION AND CORRESPONDENCE.

THE UNIVERSITY OF WEST VIRGINIA.

WITH the final resignation of Jerome Hall Raymond, last March, from the presidency of West Virginia University, and the election of Dr. Purinton, of Denison, to succeed him, another turbulent period in the history of that institution has come to an end.

It is worth noting that no one of the six men who have served as presidents of the West Virginia University since its foundation in 1867 has proved generally acceptable to the people of the State, and that no one has been less acceptable than President Raymond. And yet, according to a statement made to the writer by one member of the University faculty who has always lived in Morgantown, no other president began his work under more auspicious circumstances. The board of regents had a good working majority of intelligent men who were deeply interested in the welfare of the University and who were anxious to give a hearty support to their enthusiastic young president. The people in the surrounding community and the members of the faculty were also more friendly and more inclined to be pleased with Mr. Raymond than they had been with any of his predecessors.

Notwithstanding all this, trouble was inevitable. The president was young, aggressive and thoroughly saturated with the spirit of unlimited, rushing expansion which had prevailed in the University of Chicago during the preceding five years. The faculty of the West Virginia University, on the other hand, did not at that time (1897) contain a single Ph.D. from any reputable university. Some of the professors were therefore naturally unfit to be in charge of any department in a modern college or university, and their unfitness became especially glaring through the new president's vigorous attempts to convert the old Morgantown institution into a miniature copy of the

University of Chicago. Several of the professors, moreover, not only lacked the training necessary to make them competent instructors in a university, but were in addition so addicted to financial schemes and to politics as to be a hindrance to the peaceful development of any state institution of learning.

Unhampered and alone, Mr. Raymond succeeded for a time in carrying out his plans in the management of the University. The University catalogue was entirely remodeled on the plan of the University of Chicago catalogue, and the studies were correspondingly rearranged; the summer quarter was added, and the four-quarter system with the 'quarterly convocations' was introduced; an unlimited elective system of studies leading to one degree only (B.A.) was adopted; faculty meetings were abolished, and the president's plans and changes were all carried out by means of committees of his own appointment.

All these changes and many others less fundamental, though scarcely less irritating to one or another among the professors, followed in rapid succession. One by one the older members of the faculty came to feel that they were entirely unsatisfactory and that the president would like nothing better than to replace them as soon as possible by men of his own selection. This led to a tacit or open combination of the greater number of the professors against the president—a result which might have been expected, especially considering the records of forced resignations, reappointments and quarrels of various kinds which formed a part of the previous history of the University. The opposition spread rapidly not only among the students and the people of Morgantown but also throughout the State, where it unfortunately developed into a narrow-minded support of 'West Virginians' as against 'foreigners.' The temper of some of the crudest of Mr. Raymond's enemies is well illustrated by the extravagant vulgarity of the attacks which were made upon him during the winter and spring of 1900 by the *Clarksburg News* and the *New Dominion* of Morgantown. The unpopularity of the president alike among the faculty, students and the people, especially the local people, was in addition much increased by his

pronounced antagonism toward smoking, drinking and dancing. His unfailing and uncompromising defence of the doctrine of evolution in season and out of season further brought him into sharp antagonism with the strong church-going element of the State.

Nor did the new members of the faculty whom the president brought to the university serve to strengthen his position, partly because the local animosity against the president was turned into suspicious reserve toward these who were supposed to be his friends, and partly because there was probably not a single one among them who did not disapprove of the president's policy in one or another essential point. It must be noted that the president did his utmost to secure the most able and well-trained young men that the salaries offered could procure; but the policy of the university was not in the least affected thereby, because President Raymond continued to settle all questions himself, and the new professors as well as the old were distributed among the various committees so as to insure a majority in favor of the president's views.

No fair-minded person can doubt that President Raymond worked as only a man in his best years can work for the advancement of the university. To be sure considerable energy and some money were wasted on untimely features, such as the premedical course, the domestic science, the department of pharmacy, the work for Ph.D., and the correspondence courses. But after all this has been admitted there can be no doubt that the standard of scholarship was raised through Dr. Raymond's efforts far above what it had ever been before in West Virginia.

The most striking illustration of this general advancement is perhaps to be found in the equipment and management of the university library at the beginning and at the end of Mr. Raymond's administration. Before his arrival the books were all inside an iron railing, and in charge of a lady who did not pretend to know anything about the classification of books. Her chief function was to see that the books did not disappear. The place was open less than six hours a day, and during those hours the space outside the iron railing is said to have been the noisiest and most disorderly place on the

campus. This fall a thoroughly modern library building is being finished, and, what is more to the point, the library has been as pleasant, orderly, and well arranged as any one could wish during at least the last two years, that is, ever since the present librarian was able to bring order out of the previous chaos. The library is now open from 8 a. m. to 10 p. m., every week-day, and from 4 to 6 p. m. on Sundays and holidays. The amount of money which was spent for current literature and books under President Raymond's regime was also about all that could reasonably have been asked for, and this money was largely spent under the direction of the young instructors whom he had brought there, because there seemed to be very little demand for more literature from the older professors. Several departments of the university are now fairly well equipped with standard and recent literature.

Another striking illustration of how Mr. Raymond endeavored to raise the standard of the work done in the university is found in the changes which he introduced in the scientific departments. At the beginning of his administration botany, zoology, physiology, anatomy, and materia medica were taught by one man (an M.D.). During the last two years anatomy was not taught, and the other four subjects were represented by two Ph.D.'s and one M.D. Another Ph.D. was appointed assistant professor in chemistry. The department of physics was not changed, but it was well known that this was due only to the fact that the president could not change everything at once.

The climax came in the spring of 1900 when the president asked the board of regents for the resignation of five of the old professors, and in addition formally expressed his disapproval of two others as well as of the director of the experiment station. This step, bold and ill-advised as it seemed, was partly a measure of self-protection, for some of the men whose resignations were demanded were then openly doing everything in their power to bring about the downfall of Mr. Raymond. The board of regents did not grant the president's request, because four of the nine members composing the board were at this time opposed to the president, and further, because to grant such a request then

would almost certainly have brought the University into the politics of the State during the elections of last fall. The failure of the board to support the president on such an important matter left him, on the other hand, no other dignified course than to resign. The following letter of resignation was indeed promptly sent to the board :

TO THE HONORABLE BOARD OF REGENTS.

Gentlemen : I hereby place in your hands my resignation of the Presidency of West Virginia University.

I am moved to do this, and thus to give up some of the most deeply cherished hopes of my life, because I see no prospect of final success in my work.

It is impossible to build up a university save on the basis of sound morals and sound scholarship with the generous cooperation of those engaged in the work. I have asked the removal of certain men known to you and to me and to the community to be grossly deficient in one or all of these regards. This demand your honorable Board has refused to grant for reasons which I cannot deem sufficient. I therefore ask you to relieve me of my responsibility for the conduct of the University, this act to take effect June 2, 1900.

Respectfully,

JEROME H. RAYMOND.

The board refused to accept this letter of resignation by a vote of five to four. President Raymond's friends on the board thereupon persuaded him to withdraw the letter.

As soon as the fall elections were over two of the resignations which Mr. Raymond had asked for were demanded by the board of regents (by a vote of five to four). The men refused to resign, and the subject was brought into the courts. The right of the board to dismiss the professors was sustained by the court by a vote of two to one, the judge who voted against the board being a relative of one of the dismissed professors. A private libel suit was at the same time instituted by one of the dismissed men against the president. This suit is still pending and is not expected to be dropped, because the prosecuting attorney is as bitter an enemy of the president as is his client.

The last chapter of President Raymond's career in West Virginia followed in the spring. The legislature was in session, and appropriations had to be asked for by the board

of regents. The report which they submitted to the legislature is a strong, well-written statement of how the University affairs were managed. Nothing could, however, stem the tide of feeling which had been worked up against the president. The legislature ordered an investigation into the affairs of the University. The essential points of the report which was submitted to the legislature by the committee appointed to carry out this investigation are contained in the following paragraph closing the report :

Your committee was at great pains to investigate the criticisms that have been generally made through the state in regard to the executive head of the University. A great deal of testimony was before the committee upon this subject. The president of the University is to be commended for his zeal and energy and devotion to the work of his office. We, however, regard some of his views and policies as not suited to the conditions as they exist among us. This together with his youth and inexperience and want of tact in dealing with men lead us to the conclusion that the best interests of the University would be subserved by a change in the presidency thereof. We are led to this conclusion by the overwhelming force of the evidence before us in our investigation, and we, therefore, recommend that such change shall be made.

Along with this change, it is the further opinion of your committee that there should be a complete reorganization of the board of regents, and that in such reorganization there should be no local regent appointed upon the new board.

There can be no doubt that the report of the committee reflected the prevailing sentiment in the legislature. The investigation could, however, not have been very thorough since it lasted but two days ; nor could the report submitted have been exclusively intended to improve the management of the affairs of the University. This is clearly shown for instance in the following paragraph.

In view of the great prominence given in colleges to physical exercise, the committee is of the opinion that the instructor in the gymnasium, who now receives a salary of only eight hundred dollars, should receive the salary of a full professor.

The instructor in question was an undergraduate student whose record of scholarship

during at least one quarter of the year '99-'00 fell below the average necessary for permission to continue his studies.

Mr. Raymond's administration ended precipitately after this report had been presented to the legislature. To the bill providing funds for the maintenance of the University was added a clause which stipulated that none of the funds could be used until Mr. Raymond's resignation had been accepted by the board of regents. Both the president and the board that had supported him were thus legislated out of office.

The new board met in June and elected Dr. Purinton, of Denison, to the presidency of West Virginia University. The following additional changes have since been made in the management of the instruction at the University: The professor of botany was dispensed with on economic grounds, and the department of botany was left in charge of the professor of zoology. The professor of philosophy was given the department of economics, the new president taking charge of the department of philosophy. The premedical and the domestic science departments were abolished, and the head of the domestic science, a Ph.D. in sociology, was made assistant professor of sociology. One of the two professors who had been compelled to resign in the fall by the old board of regents was reelected for one year, and for that year was given a leave of absence without pay. The departments of English literature and rhetoric were divided, and the English literature was given to a Morgantown lady without university training, who had attained some local literary distinction as secretary of the Morgantown Fortnightly Club. The assistant in rhetoric was offered an assistantship in mathematics, and on refusing to teach mathematics was dropped. The professor of German the following day went before the board in regard to their action on the assistant in rhetoric, and as a result the latter was reinstated with an increase of salary of three hundred dollars.

In view of all that has happened at West Virginia University during the past year, it is not easy to foresee what will be its history in the immediate future.

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CANNONADE AGAINST HAIL STORMS.

TO THE EDITOR OF SCIENCE: My attention has been called to an article by Professor W. S. Franklin, in your esteemed journal of September 27, page 496, on the control of the weather.

Professor Franklin's argument for the rational plausibility and possible effectiveness of cannonading with vortex rings 'for *inaugurating* at will the storm movements of atmosphere' is very surprising in view of two facts: 1st, Stiger and his followers do not maintain that the rising vortex rings *initiate* storms, but that they *destroy* storms, at least hail storms, turning them aside from their intended paths or converting the hail to rain; 2d, the cannonade against hail has been prosecuted for centuries, and the special vortex ring cannonade has been practised by tens of thousands during the past three years, and yet thus far there has not been reported a single case where cannonading has been logically demonstrated to have been effectual. Hail storms move, divide and pass by on either side, develop and decay, just the same whether the cannons are fired or no! The popular faith in cannonading that seems to prevail among the peasantry of southern Europe is a craze that has no scientific basis whatever. If Professor Franklin has any faith in this process he has but to submit it to a thorough experimental trial: Get a dozen of his neighbors to load their rifles with five ounces of gunpowder, which is the charge recommended by Stiger, leave off the wad so as not to burst the guns, and all fire away as fast as possible when a hail storm is approaching. After actually witnessing the failure of this process let him sit down and calculate approximately the relative amounts of energy in the explosions and in the hail storm.

The importance of unstable equilibrium in the atmosphere is a matter that has been so thoroughly investigated since the days of Espy, that Professor Franklin has only to study the modern literature of meteorology and the mechanics of whirlwinds in order to realize the folly of his argumentation.

The Weather Bureau needs, and hopes to obtain, the hearty cooperation of the best men in American science in order to overcome the dif-

difficulties inherent in the study of meteorology, but I believe that such suggestions as those of Professor Franklin are not the best that science has to offer.

CLEVELAND ABBE.

THE SACRAMENTO FOREST.

TO THE EDITOR OF SCIENCE: In south central New Mexico, capping the scarp of the great monoclinical mountain known as the Sacramento, and overlooking to the west the Tularosa desert, is a unique and beautiful forest tract. It forms a detaining mat of vegetation which supplies a large group of running streams and their dependent agriculture. It is, also, a moist and forested resort for the vast desert which encircles it for hundreds of miles. Already 150 miles of railway carry many tourists north from El Paso to picturesque Cloudcroft from all parts of Texas, Arizona and New Mexico; when the scenic beauties of the place are more widely known, the place will become a Mecca for lovers of nature.

The forests consist of pines, firs and balsams, of many species and of great size, trees twenty-five feet in diameter being quite common.

In all there are about twenty-five townships of forested land, some of which is included in the Mescalero Indian reservation.

Saw mills are already at work devastating this little-known but beautiful forest area. The importance of preserving this watershed cannot be too strongly insisted upon and it is hoped that all friends of forestry will use their influence to this end.

ROBERT T. HILL.

October 19, 1901.

THE WORK OF THE BEAUFORT LABORATORY OF THE U. S. FISH COMMISSION.

UNDER the administration of the present commissioner, Hon. Geo. M. Bowers, the facilities for biological investigation at the Beaufort (N. C.) Laboratory of the U. S. Fish Commission are constantly increasing. During the past season the laboratory was open from the middle of May until the end of September, and every reasonable request for equipment was granted. Tables were occupied by the following gentlemen, grouped under the institutions

with which they are connected: *Bryn Mawr College*, Professor T. H. Morgan. *Columbia University*, Professor E. B. Wilson, Mr. H. B. Torrey, Mr. J. C. Torrey. *Dartmouth College*, Dr. J. H. Gerould. *Johns Hopkins University*, Professor W. K. Brooks, Dr. Caswell Grave, Mr. R. P. Cowles, Mr. D. H. Tennent, Mr. O. C. Glaser, Mr. R. E. Coker, Mr. J. A. E. Eyster. *University of Alabama*, Professor J. Y. Graham. *University of Missouri*, Professor Geo. Lefevre, Dr. W. C. Curtis. *University of North Carolina*, Professor H. V. Wilson, Mr. C. A. Shore. *Washington and Jefferson College*, Professor Edwin Linton, Mr. C. W. Stone. The investigations carried on were of a varied character, embracing such diverse problems as the systematic zoology and natural history of parasites in edible fish; the effect on the tissues of the oyster of a prevalent trematode parasite; the nature of the food and the rate of growth of planted oysters; the cell-lineage and embryology of *Thalassema*; the embryology of *Chaetopterus*, of the oyster, of *Ascidia*, of *Phoronis*; regeneration in *Phoronis*; the metamorphosis of echinids and ophiurans, of barnacles; the systematic zoology of tunicates, of sponges, of echinoderms; cell phenomena in the formation of organs in half and quarter larvæ of sea-urchins.

Many zoologists will be glad to hear that *Phoronis* (*P. architecta* Andrews) turns out to be very abundant at Beaufort. Mr. Cowles has found the form to be a tractable one, living easily in the laboratory and depositing eggs freely. Biologists who are occupied in the study of the fundamental morphogenetic activities of protoplasm will be interested to learn that the delicate striæ which have been described (Conn) as radiating from the surface of the *Thalassema* egg were found (by several observers) to be fine threads, which in places branch and anastomose. With a Zeiss 2 mm., such filaments may easily be seen over the surface of the egg after the formation of the egg membrane, and later over the free surfaces of the first blastomeres. The filaments give every evidence of being protoplasmic, and clearly belong in the category of the 'filose processes' discovered by Mrs. E. A. Andrews ('Spinning Activities of Protoplasm,' *Journ. Morphology*, VII., 2, 1897).

The work of the past season was carried on in the rented building which has served as temporary quarters for the laboratory since its inauguration three years ago. Ground was broken for the new building in September, and another year should see the station in its permanent home.

H. V. WILSON.

UNIVERSITY OF NORTH CAROLINA,

October 21, 1900.

EXHIBITION OF A STUDENTS' SOCIETY OF SCIENCE.

THE Students' Society of Science, formed by and of students in the New York City high schools, held its second annual exhibition on October 11, 1901, at the home of the president. Exhibits were shown in the departments of botany, zoology, conchology, mineralogy, paleontology, geology and anthropology.

The exhibits were in every case explained and described by printed cards. Colored plates prepared by the boys accompanied each collection and showed how the various classifications were made. The collections themselves were prepared so as to show variations of certain properties which defined each group. Thus there were separate divisions in the department of mineralogy, which described and explained each of the several properties of hardness, cleavage, color, refraction and crystallization.

The department of biology presented collections and plates explanatory of the morphological differentiation and evolution of animals, the progressive specialization of the cell, and interesting cases of plant and animal reproduction. Special studies were shown of marine invertebrate zoology, the Arthropoda, and of the structure and anatomy of birds.

The Jones conchological collection, comprising several thousand specimens from all parts of the world, and a large number of selections from the Hawley herbarium, were of particular interest and beauty.

Several large colored plates descriptive of the American fossil beds accompanied the paleontological collection, the gaps in the collection being filled by sketches and plates, which showed a remarkable degree of ingenuity and correctness of knowledge on the part of the young collectors.

The entire exhibition showed what can be done by a few earnest young students of nature who take the trouble to go below the surface of mere collecting for sport. When we consider that the oldest member of this young society is but fifteen years of age, and that they received no outside aid whatever in the preparation of their collections, the result of their work is truly remarkable.

SCIENTIFIC NOTES AND NEWS.

A MEMORIAL meeting in honor of the late Henry Augustus Rowland was held at the Johns Hopkins University, on October 16. The principal address was made by Dr. T. C. Mendenhall.

THE Sociedad española de Historia Natural de Madrid has established a new class of *socios honorarios*, limited to ten in number and at a special meeting in March last elected the following eight persons: Sir Archibald Geikie of London, Ph. van Tieghem of Paris, Adolph Engler of Berlin, Santiago Ramón y Cajal of Madrid, Carl Brunner von Wattenwyl of Vienna, Lord Avebury (Sir John Lubbock), of England, Albert Gaudry of Paris and Samuel H. Scudder of Cambridge, Mass.

ON the occasion of the celebration of Virchow's eightieth birthday last month, his bust in marble was presented to the Pathological Institute at Berlin.

DR. CHARLES E. MUNROE, professor of chemistry and dean of graduate studies in Columbian University, has been appointed by the Swedish Academy of Sciences one of the representatives to recommend candidates for the Nobel prize in chemistry.

DR. and Mrs. T. C. Mendenhall sailed from New York for the Azore Islands on October 29.

DR. L. O. HOWARD, chief entomologist of the Department of Agriculture, returned to Washington on October 27 from a protracted tour of California, Oregon, Washington, Idaho, Mexico and Texas, where he has been conducting field investigations and examining the work of field agents.

DR. ANDREW D. WHITE, ambassador to Germany and ex-president of Cornell University, returned to his post in Berlin on October 31.

PROFESSOR WILLIAM LIBBEY, of Princeton University, and his family have sailed for Europe and will be absent for a year.

It is reported that the Duke of the Abruzzi will visit the United States next February, with a view to arranging for another expedition to the North Pole.

DR. WILHELM WALDEYER, professor of anatomy at Berlin, was entertained at dinner in New York City on October 26. Addresses were made by Drs. George W. Jacobi, A. Jacobi, William H. Welch and Carl Beck.

DR. OTTO NORDENSKJÖLD, leader of the Swedish Antarctic expedition, was entertained by Sir Clements Markham, president of the Royal Geographical Society at the Royal Society's Club, London, on October 25. The *Antarctic* left Falmouth the following day for Buenos Ayres and the Falkland Islands.

DRS. BEYER, Formento and Salomon, of New Orleans, have been appointed civilian members of the government Yellow Fever Institute.

DR. R. G. PERKINS has been given an appointment to carry on research at Western Reserve University under the Rockefeller Institute for Medical Research. Similar appointments at McGill University have been given to Dr. G. A. Charlton and Dr. P. G. Wooley.

PROFESSOR HUGO MÜNSTERBERG, of Harvard University, will give a series of eight Lowell lectures at the Massachusetts Institute of Technology, beginning on November 11, on 'The Results of Experimental Psychology.'

MR. GEROW D. BRILLE, a graduate of Cornell University, has been appointed director of the Agricultural School and Experiment Station, to be established by the United States Government on the island of Negros in the Philippines.

W. D. STRAIGHT, instructor in drawing in Cornell University, has resigned to accept a position in the customs service in China.

PROFESSOR LAWRENCE BRUNER and a party from the department of entomology and ornithology of the University of Nebraska, as we learn from *The Auk*, spent during the early summer some time in the Pine Ridge region of northwestern Nebraska, investigating the birds of the region and making collections.

DR. REID HUNT, associate professor of pharmacology in the Johns Hopkins Medical School has spent the summer at the Montana Agricultural Experiment Station, Bozeman, investigating certain poisonous plants for the U. S. Department of Agriculture. Part of the work was done in conjunction with Mr. V. K. Chestnut, of Washington. Considerable attention was given to one of the so-called 'loco' or crazy weeds, and some progress was made in discovering the mode of action of this plant, which has baffled investigators for so many years.

THE *Revue générale des sciences*, as we have already noted, organized this year a scientific excursion to Asia Minor and Palestine. The party sailed from Marseilles on September 14 on the steamship *Senegal*, chartered for the excursion. Shortly afterwards two members of the crew were found to be affected with the plague, and the steamship returned. There were a number of scientific and medical men in the party.

SIX deaths from the bubonic plague have occurred at Liverpool, and the disease has reappeared in Glasgow.

DR. CALMETTE, director of the Pasteur Institute at Lille, was, as we recently reported, bitten in the hand by one of his rattlesnakes while he was making experiments. Dr. Calmette immediately inoculated himself with his antivenomous serum, but it was found necessary to amputate one of his fingers.

THE Royal University of Ireland has conferred its D.Sc. on Mr. Walter Noel Hartley, F.R.S., professor of chemistry in the Royal College of Science for Ireland.

SURGEON-GENERAL W. TAYLOR, M.D., C.B., has been appointed Director-General of the British army medical service.

THE fund which is being raised to found a memorial to the late Dr. D. J. Leech, for twenty years professor of materia medica and therapeutics at the Owens College, Manchester, has now reached the sum of £1,230.

PRIVY COUNCILOR MAERCKER, professor of agricultural chemistry at the University of Halle, died on October 20.

CANNON ISAAC TAYLOR, the author of an excellent work on 'The Alphabet' and other archeological books, died on October 18 at the age of seventy-two years.

THE eleventh congress of Russian Naturalists and Physicians will meet at St. Petersburg on January 2, and will remain in session for ten to eleven days. The sections into which the association is divided are mathematics and mechanics, astronomy and geodesy, physics, physical geography, geography and statistics, agriculture, chemistry, geology and mineralogy, botany, zoology, anatomy and physiology, scientific medicine, and hygiene. Three days are to be devoted to general sessions and seven days to the meetings of the sections.

AT the recent International Congress of Criminal Anthropology at Amsterdam it was decided that the next congress will be held at Turin in 1906.

AN Australasian Ornithologists' Union is about to hold its first meeting at Adelaide. The society will publish a magazine called *The Emu*.

A COMMISSION, under the presidency of M. Léon Bourgeois, has recommended the addition of new laboratories to the Conservatoire des arts et métiers at a cost of about \$100,000.

THE Berlin correspondent of the *British Medical Journal* writes that the 'Virchow Day' lengthened out to a 'Virchow Week,' for the series of ovations that began on Saturday, October 12, did not find their close until Friday, October 18. On Monday evening, October 14, the Imperial Chancellor and Countess von Bülow gave a dinner in honor of Virchow, at which many of the foreign delegates and Berlin notabilities were present. On Tuesday evening an imposing public meeting gave evidence of the enthusiasm felt by the Berlin Liberals for Virchow as a politician. Eugen Richter, the great radical orator, made a flaming speech, in which sharp hits at the present political situation alternated with expressions of deepest gratitude for Virchow's untiring, courageous and lifelong labors in the cause of political freedom. That Virchow's political career has been one of real work can be best illustrated by the fact that for twenty-five years he was presi-

dent of the parliamentary audit committee. On Friday evening the town council and magistrates gave their great Virchow banquet in the city hall. What Virchow has done for public hygiene and town sanitation is known all over the world. No one could have put into better words the debt our generation owes him than did Virchow himself, when, in returning thanks for the speech in his honor, he said—without mock humility and without vanity either—that if he was proud of any achievements it must be the achievements in the domain of public health, since it was by his efforts, through the establishment of the system of drainage which he had recommended and the sewage farms constructed under his directions, that Berlin had become the healthiest city in the world. All the medals, addresses, pieces of statuary and paintings presented to Professor Virchow by learned societies and public personages are on view in the Central Hall of the Industrial Art Museum.

THE London *Times* states that the Crystal Palace authorities have decided to hold an American exhibition next year. It will be strictly confined to a display of the wealth, industry, science and art of the United States. The space of the palace will be divided so as to allow the exhibits to be ranged into ten classes, which will be found to cover exhaustively the vast resources, instructive and interesting, of that country. During the exhibition some of the leading American entertainments and shows will be introduced, in addition to the regular palace program, and in the grounds characteristic American sports will be conducted by representative teams. An important feature in connection with the exhibition will be the institution of a commercial bureau, under the direction of a committee of representative American and British firms. An American advisory committee has been formed, consisting of the officers, general committee and many prominent members of the American Society in London, who are working in co-operation with Mr. Henry Gillman to make the exhibition the most complete and representative one ever held. The English advisory committee includes the Lord Mayor, Earl Grey, the Earl of Crewe, Sir Douglas Fox, Viscount Dun-

cannon, Sir Henry Irving and Mr. Winston Churchill, M.P. Mr. Ernest Schenk, chairman of the Crystal Palace Company, has been for some time in America in connection with the arrangements, and has everywhere met with most cordial approval of the project. The American exhibition will extend from May to September.

THE Department of Agriculture is in receipt of a communication from Mr. R. J. Alfonso, agronomical engineer in Cuba, and secretary of the provincial 'Junta' of agriculture, commerce and industries of the Province of Puerto-Principe, in which he expresses his desire to be brought in contact with some of the leading manufacturers of agricultural implements in the United States in the hope that some of them may be induced to contribute to the agricultural museum his association is in process of organizing some of their implements, or models of the same. He expresses the hope that their enterprise and liberality in this respect would not go unrewarded, as such exhibits would serve a very useful purpose in the way of advertising their manufactures.

WE learn from the *London Times* that the committee appointed by the Board of Trade to inquire and report as to the best means by which the state or local authorities can assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland has met for the purpose of taking evidence. Sir Herbert Maxwell, M.P., presided. Dr. T. Wemyss Fulton, scientific superintendent to the Scottish Fishery Board, and Mr. E. W. L. Holt, scientific adviser to the fisheries branch of the Department of Agriculture, etc., Ireland, were examined, and Mr. G. C. Bompas and Professor G. B. Howes gave evidence with regard to the Buckland fish collection at South Kensington. Professor E. Ray Lankester, the president, and Mr. E. L. Allen, the director of the Marine Biological Association, and Mr. R. A. Dawson, superintendent under the Lancashire and Western Sea Fisheries Committee, also attended. Professor Herdman, F.R.S., a member of the committee, submitted a scheme for fishery investigations in the Irish Sea.

A BRITISH foreign office report gives some information regarding the bill on the subject of

the draining of the Zuyder Zee recently introduced in the Second Chamber of the States-General by Mr. Lely, the Minister for the Waterstaat, who likewise furnished the Chamber with a memorandum in explanation of the measure, giving a historical retrospect of all former proposals of this nature, as also the most complete details concerning his own proposal. It appears from the *London Times* that the plan consists of first enclosing and afterwards gradually partially reclaiming the Zuyder Zee, the pumping out of the water to be effected by steam pumps. The first work will be the construction of a dam from Wieringen, in North Holland, to Piaam, in Friesland. This dam will have sluices into the North Sea. The next works will be the creation of two polders, or areas of dry land reclaimed from the Zuyder Zee; the first, between Wieringen and Medemblik, to be called the 'North-West,' or 'Wieringen Polder,' and the second, between Hoorn and Marken, to be called the 'South-West,' or 'Hoorn-Polder.' The rest will remain a fresh-water lake, at all events in so far as Mr. Lely's plan is concerned, but should the latter prove successful, his ministerial successors may in days to come create two more polders on the northeast and south-east of the lake. The two polders will be of the following area, viz., the Wieringen Polder, 21,700 hectares, containing 18,700 hectares of fertile land; and the Hoorn Polder, 31,520 hectares, containing 27,820 hectares of fertile land. The entire work is to be completed in 18 years. The enclosing dyke from Wieringen to Piaam will be finished in the ninth year. In the eighth year will be commenced the works for dyking the Wieringen Polder, which in the 14th year will be dry and ready for sale. In the 11th year the similar works on the Hoorn Polder will be begun, and will be completed in the 18th year, when an area of upwards of 46,500 hectares of fertile soil will have been reclaimed. The cost of this gigantic work is estimated in round numbers at 95,000,000*fl.* (£7,916,667), which amount is to be raised by loans, and it is proposed to pay off the principal and interest by an annual increase of the Budget of 2,000,000*fl.* (£166,667) during a *maximum* period of 60 years.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Council of Birmingham University have authorized the preparation of plans for buildings to cost about \$1,000,000.

THE engineering departments of Leland Stanford University have been granted \$50,000 for equipments.

A BACTERIOLOGICAL laboratory is to be erected at the State Agricultural College, Lansing, Mich., at a cost of \$50,000. This sum does not include the cost of the equipment, which will be the best attainable.

NORTHWESTERN University has received an anonymous gift of \$15,000.

GEORGE C. FRENCH, of Mexico, Oswego County, N. Y., has given \$4,000 to Syracuse University toward founding a chair of mathematics as a memorial to his brother, the late Dean, John R. French, of that institution.

THE professors at the Paris School of Anthropology offer the following courses for the year 1901-1902: M. Papillault: Anatomical anthropology, external form and proportions of the human body; special study of variations due to social environment. M. Capitan: Prehistoric anthropology, bases of prehistoric studies: petrography, paleontology, industry. M. André Lefevre: Ethnography and linguistics, France during the fourteenth century. Charles V. and Charles VI., the hundred years' war, letters, art, language. M. Georges Hervé: Ethnology, ethnology of Europe, Alsace. M. Adrien de Mortillet: Ethnographic technology, the industry of modern primitive races compared to tertiary and quaternary industry. M. J. V. Laborde: Biological anthropology, biological introduction to criminal anthropology. The predisposition to crime in the organic and functional evolution of man. M. Franz Schrader: Anthropological geography, terrestrial laws and human customs. M. L. Manouvrier: Physiological anthropology, comparative study of the sexes; view point of sociology. M. Charles Letourneau: Sociology [history of civilizations]; the conclusions of ethnographic and comparative sociology. M. P. G. Mahoudeau: Zoological anthropology, ori-

gin of man; genealogy of the hominidæ. The courses began on November 4 and are public; there are no tuition fees.

PROFESSOR WILLIAM S. ALDRICH, late of the University of Illinois, has entered upon his duties as director of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y. Among other recent appointments to the staff of the Clarkson School are Professor Edwin Haviland, Jr., B.S. (Swarthmore), M.A. (Cornell), who will occupy the chair of civil engineering, and Mr. W. S. Graffan, B.S. (Worcester Polytechnic Institute), who has been appointed superintendent of shops.

THE Ontario Government has appointed Dr. T. L. Walker, at present assistant superintendent of the Indian Geological Survey and curator of the Calcutta Museum of Geology, to the chair of mineralogy and petrography in Toronto University. Dr. Walker is a graduate of Queen's University, Kingston.

DR. D. S. KIMBALL has resigned the chair of machine design in Cornell University to accept a position with an electric company, and is succeeded by Dr. C. E. Coolidge. At the same university Mr. William Riley has been appointed instructor in entomology.

DR. A. E. SHUTTLEWORTH has resigned the chair of chemistry in the Ontario Agricultural College to accept a technical position. He is succeeded by Dr. Harcourt.

THE following changes in the science faculty of Syracuse University were announced at the opening of the year: C. B. Thwing, Ph.D. (Bonn), has been elected professor of physics, filling the vacancy caused by the resignation of Professor Eugene Haanel. At the time of his election Dr. Thwing was professor of physics in Knox College, Galesburg, Ill. F. A. Saunders, Ph.D. (Johns Hopkins), has been elected instructor in physics; H. C. Cooper, Ph.D. (Heidelberg), instructor in chemistry and E. H. Kraus, Ph.D. (Munich), instructor in mineralogy.

J. O. QUANTZ, Ph.D. (Wisconsin, 1897), has been called to the chair of psychology at the State Normal School at Oshkosh, Wisconsin.